PENCOYD IRON WORKS
A. & P. ROBERTS COMPANY

STEEL IN CONSTRUCTION

1898

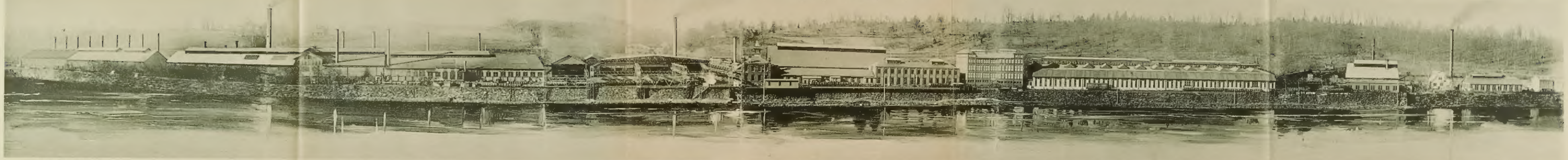
A Jarvall Evans
98

to

H. A. Evans.

Back of
Foldout
Not Imaged

PENCOYD IRON WORKS, PENCOYD, PA.



OPEN-HEARTH FURNACES. | FORGE DEPT. | ROLLING MILLS. | STRAIGHTENING AND CUTTING DEPARTMENT. | ROLLING MILLS AND MACHINE SHOP. | BRIDGE AND CONSTRUCTION DEPARTMENT. | HYDRAULIC FORGE DEPARTMENT. | BOLT AND RIVET SHOP.

A. Jarratt Lewis
to
H. A. Lewis

Steel in Construction.

CONVENIENT RULES, FORMULÆ AND TABLES FOR THE STRENGTH OF STEEL SHAPES USED AS BEAMS, STRUTS, SHAFTS, ETC.,

MADE BY

THE PENCOYD IRON WORKS,

A. & P. ROBERTS COMPANY,

PHILADELPHIA, PA.

STEEL DEPARTMENT,

MANUFACTURERS OF OPEN HEARTH STEEL SHAPES, BARS, FORGINGS, SHAFTING, AND HAMMERED AXLES.

BRIDGE AND CONSTRUCTION DEPARTMENT,

DESIGNERS AND MANUFACTURERS OF BUILDINGS, BRIDGES, VIADUCTS, TURNTABLES, ETC.

TENTH EDITION.

1898.

PENCOYD IRON WORKS

A. & P. ROBERTS CO.

PHILADELPHIA, PA.

MAIN OFFICE,
261 S. Fourth Street, Philadelphia, Pa.

BRANCH OFFICES: 100 Broadway, New York City
27 State Street, Boston, Mass.

AGENCIES:

R. C. HOFFMAN & CO.
Equitable Building, Baltimore, Md.

E. W. CRAMER,
The Rookery, Chicago, Ills.

WM. V. KELLEY,
1506 Fisher Building, Chicago, Ills.

GOOD & WATERMAN,
Security Building, St. Louis, Mo.

JAMES W. PYKE & CO.,
35 St. François Xavier St., Montreal, Canada.

J. F. CORLETT,
Perry-Payne Building, Cleveland, O.

PREFACE.

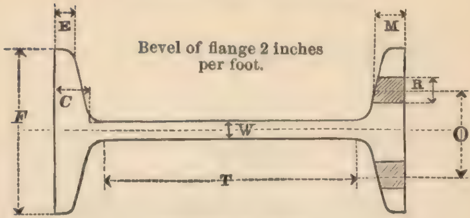
Two years have elapsed since the Ninth Edition of this book was issued. During this time the contents have been thoroughly revised and much new matter added. A number of new sections will be found in the lists, especially large beams and angles.

The text and tables have, as in former editions, been very carefully prepared under the supervision of Mr. James Christie, and we trust may be of value to all who have occasion to use the products of the Pencoyd Iron Works.

A. & P. ROBERTS COMPANY.

PENCOYD, PA., *February 16, 1898.*

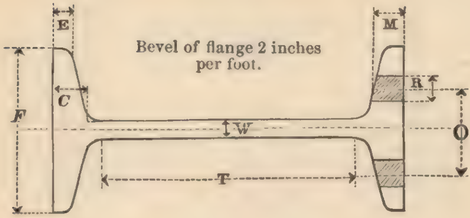
PENCOYD BEAMS.



Dimensions in inches.

Section Number.	*Size of Beam.*	*Weight Pounds per Foot.*	*Area of Section.*	*W.*	*F.*	*C.*	*E.*	*O.*	*R.*	*M.*	*T.*
240B	24	80.0	23.53	.50	7.00	1.14	.60	4.50		.81	20.70
241B	24	85.0	25.00	.56	7.06	1.14	.60	4.50		.81	20.70
242B	24	90.0	26.47	.56	7.42	1.21	.64	4.50		.88	20.48
243B	24	95.0	27.92	.62	7.48	1.21	.64	4.50		.89	20.48
244B	24	100.0	29.42	.68	7.54	1.21	.64	4.50		.89	20.48
200B	20	65.0	19.12	.50	6.25	1.03	.55	4.00		.74	16.92
201B	20	70.0	20.59	.56	6.31	1.03	.55	4.00		.74	16.92
202B	20	75.0	22.06	.64	6.39	1.03	.55	4.00		.75	16.92
203B	20	80.0	23.53	.63	6.75	1.12	.61	4.25		.82	16.52
204B	20	85.0	25.00	.70	6.82	1.12	.61	4.25		.82	16.52
205B	20	90.0	26.47	.78	6.90	1.12	.61	4.25		.83	16.52
206B	20	95.0	27.94	.74	7.24	1.25	.68	4.50		.92	15.86
207B	20	100.0	29.41	.81	7.31	1.25	.68	4.50		.93	15.86
180B	18	55.0	16.18	.46	6.00	.92	.46	3.75		.65	15.19
181B	18	60.0	17.65	.54	6.08	.92	.46	3.75	¾	.65	15.19
182B	18	65.0	19.12	.63	6.17	.92	.46	3.75		.66	15.19
183B	18	70.0	20.59	.62	6.50	1.01	.52	4.00	to	.73	14.76
184B	18	75.0	22.06	.71	6.58	1.01	.52	4.00	⅞	.74	14.76
185B	18	80.0	23.53	.79	6.66	1.01	.52	4.00		.74	14.76
186B	18	85.0	25.00	.74	7.00	1.16	.61	4.50		.83	14.04
187B	18	90.0	26.47	.82	7.08	1.16	.61	4.50		.84	14.04
150B	15	42.0	12.35	.41	5.50	.83	.41	3.25		.60	12.47
151B	15	45.0	13.23	.45	5.54	.83	.41	3.25		.60	12.47
152B	15	50.0	14.70	.48	5.82	.90	.46	3.50		.65	12.21
153B	15	55.0	16.18	.58	5.92	.90	.46	3.50		.66	12.21
154B	15	60.0	17.65	.55	6.17	1.04	.57	3.75		.77	11.82
155B	15	65.0	19.12	.65	6.27	1.04	.57	3.75		.78	11.82
156B	15	70.0	20.58	.63	6.43	1.17	.69	4.00		.89	11.41
157B	15	75.0	22.06	.73	6.53	1.17	.69	4.00		.90	11.41
158B	15	80.0	23.53	.83	6.63	1.17	.69	4.00		.91	11.41

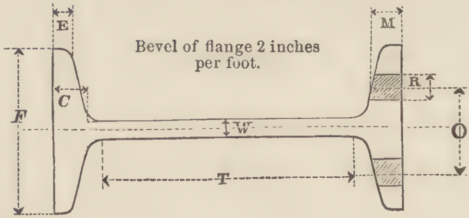
PENCOYD BEAMS.



Dimensions in inches.

Section Number.	*Size of Beam.*	*Weight Pounds per Foot.*	*Area of Section.*	*W.*	*F.*	*C.*	*E.*	*O.*	*R.*	*M.*	*T.*
120B	12	31.5	9.26	.35	5.00	.74	.35	3.00	3/4 to 7/8	.52	9.76
121B	12	35.0	10.29	.42	5.07	.74	.35	3.00	3/4 to 7/8	.52	9.76
122B	12	40.0	11.76	.42	5.25	.88	.48	3.25	3/4 to 7/8	.65	9.35
123B	12	45.0	13.23	.54	5.37	.88	.48	3.25	3/4 to 7/8	.66	9.35
124B	12	50.0	14.70	.55	5.68	.98	.56	3.50	3/4 to 7/8	.74	9.04
125B	12	55.0	16.18	.56	5.75	1.10	.67	3.50	3/4 to 7/8	.86	8.68
126B	12	60.0	17.65	.68	5.87	1.10	.67	3.50	3/4 to 7/8	.87	8.68
127B	12	65.0	19.12	.80	5.99	1.10	.67	3.50	3/4 to 7/8	.88	8.68
100B	10	25.0	7.35	.31	4.66	.67	.31	2.75	3/4	.47	7.96
101B	10	30.0	8.82	.44	4.79	.67	.31	2.75	3/4	.48	7.96
102B	10	35.0	10.29	.44	5.00	.81	.43	3.00	3/4	.60	7.47
103B	10	40.0	11.76	.59	5.15	.81	.43	3.00	3/4	.61	7.47
90B	9	21.0	6.18	.29	4.33	.63	.29	2.50	3/4	.44	7.09
91B	9	25.0	7.35	.39	4.43	.63	.29	2.50	3/4	.45	7.09
92B	9	30.0	8.82	.56	4.60	.63	.29	2.75	3/4	.45	7.09
93B	9	35.0	10.29	.72	4.76	.63	.29	2.75	3/4	.46	7.09
80B	8	18.0	5.29	.27	4.00	.58	.27	2.25	3/4	.42	6.21
81B	8	20.5	6.03	.34	4.07	.58	.27	2.25	3/4	.42	6.21
82B	8	23.0	6.76	.44	4.17	.58	.27	2.50	3/4	.41	6.21
83B	8	25.5	7.50	.53	4.26	.58	.27	2.50	3/4	.42	6.21

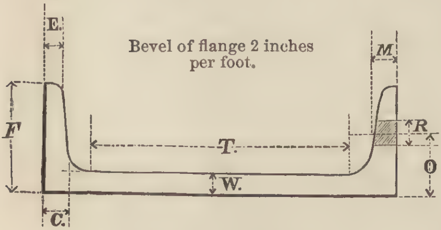
PENCOYD BEAMS.



Dimensions in inches.

Section Number.	*Size of Beam.*	*Weight Pounds per Foot.*	*Area of Section.*	*W.*	*F.*	*C.*	*E.*	*O.*	*R.*	*M.*	*T.*
70B	7	15.0	4.41	.25	3.66	.53	.25	2.00	3/4	.39	5.34
71B	7	17.5	5.15	.34	3.75	.53	.25	2.00	3/4	.39	5.34
72B	7	20.0	5.88	.45	3.86	.53	.25	2.25	3/4	.38	5.34
60B	6	12.25	3.60	.23	3.33	.49	.23	1.75	5/8	.36	4.46
61B	6	14.75	4.34	.34	3.44	.49	.23	1.75	5/8	.37	4.46
62B	6	17.25	5.07	.46	3.56	.49	.23	2.00	5/8	.36	4.46
50B	5	9.75	2.87	.21	3.00	.44	.21	1.75	5/8	.31	3.59
51B	5	12.25	3.60	.34	3.13	.44	.21	1.75	5/8	.32	3.59
52B	5	14.75	4.34	.49	3.28	.44	.21	2.00	5/8	.32	3.59
40B	4	7.50	2.20	.19	2.66	.40	.19	1.50	1/2	.29	2.72
41B	4	8.50	2.50	.24	2.71	.40	.19	1.50	1/2	.29	2.72
42B	4	9.50	2.79	.32	2.79	.40	.19	1.75	1/2	.28	2.72
43B	4	10.50	3.09	.39	2.86	.40	.19	1.75	1/2	.28	2.72
30B	3	5.50	1.62	.17	2.33	.35	.17	1.25	1/2	.26	1.85
31B	3	6.50	1.91	.24	2.40	.35	.17	1.25	1/2	.27	1.85
32B	3	7.50	2.20	.34	2.50	.35	.17	1.50	1/2	.25	1.85
63B	6	32.3 to 37.4	9.49 to 10.99	.50	4.88	.87	.50	3.00	5/8 to 3/4	.66	3.00
67B	6	41.0 to 46.1	12.06 to 13.56	.63	5.25	1.06	.62	3.25	3/4 to 7/8	.81	2.60

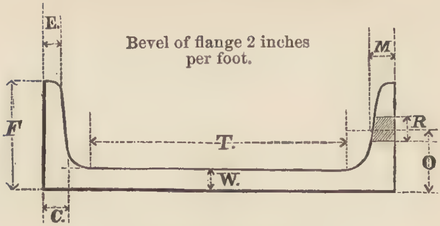
PENCOYD CHANNELS.



Dimensions in inches.

Section Number.	*Size of Channel.*	*Weight Pounds per Foot.*	*Area of Section.*	*W.*	*F.*	*C.*	*E.*	*O.*	*R.*	*M.*	*T.*
150C	15	33.0	9.70	.40	3.40	.90	.40	2.00	3/4 to 7/8	.63	12.35
151C	15	35.0	10.29	.42	3.42	.90	.40	2.00	3/4 to 7/8	.64	12.35
152C	15	40.0	11.76	.52	3.52	.90	.40	2.13	3/4 to 7/8	.63	12.35
153C	15	45.0	13.23	.62	3.62	.90	.40	2.25	3/4 to 7/8	.63	12.35
154C	15	50.0	14.70	.63	4.00	1.05	.49	2.50	3/4 to 7/8	.74	11.89
155C	15	55.0	16.18	.72	4.09	1.05	.49	2.63	3/4 to 7/8	.73	11.89
120C	12	20.5	6.03	.28	2.94	.72	.28	1.75	3/4	.48	9.91
121C	12	25.0	7.35	.39	3.05	.72	.28	1.88	3/4	.47	9.91
122C	12	30.0	8.82	.51	3.17	.72	.28	2.00	3/4	.47	9.91
123C	12	35.0	10.29	.50	3.50	.95	.45	2.00	3/4 to 7/8	.70	9.17
124C	12	40.0	11.76	.62	3.62	.95	.45	2.13	3/4 to 7/8	.70	9.17
100C	10	15.0	4.41	.24	2.60	.63	.24	1.50	3/4	.42	8.16
101C	10	20.0	5.88	.38	2.74	.63	.24	1.63	3/4	.42	8.16
102C	10	25.0	7.35	.45	2.91	.76	.36	1.75	3/4 to 7/8	.55	7.68
103C	10	30.0	8.82	.60	3.06	.76	.36	1.88	3/4 to 7/8	.55	7.68
104C	10	35.0	10.29	.75	3.21	.76	.36	2.00	3/4 to 7/8	.56	7.68
90C	9	13.25	3.90	.23	2.43	.60	.23	1.38	3/4	.41	7.25
91C	9	15.00	4.41	.28	2.48	.60	.23	1.38	3/4	.42	7.25
92C	9	20.00	5.88	.38	2.72	.71	.32	1.50	3/4	.52	6.87
93C	9	25.00	7.35	.54	2.88	.71	.32	1.63	3/4	.53	6.87
128C	12	20.5	6.03	.28	2.61	.73	.34	1.50	3/4	.53	9.49
		to	to	to	to						
	12	32.0	9.41	.56	2.89	.73	.34	1.75	3/4	.53	9.49

PENCOYD CHANNELS.



Dimensions in inches.

Section Number.	Size of Channel.	Weight Pounds per Foot.	Area of Section.	W.	F.	C.	E.	O.	R.	M.	T.
80C	8	11.25	3.31	.22	2.26	.56	.22	1.25	3/4	.38	6.34
81C	8	13.75	4.04	.30	2.34	.56	.22	1.38	3/4	.38	6.34
82C	8	16.25	4.78	.33	2.55	.65	.28	1.50	3/4	.46	6.06
83C	8	18.75	5.51	.42	2.64	.65	.28	1.50	3/4	.47	6.06
84C	8	21.25	6.25	.52	2.74	.65	.28	1.56	3/4	.48	6.06
70C	7	9.75	2.87	.21	2.09	.52	.21	1.13	5/8	.37	5.43
71C	7	12.25	3.60	.31	2.19	.52	.21	1.25	5/8	.37	5.43
72C	7	14.75	4.34	.36	2.46	.60	.25	1.50	5/8 to 3/4	.41	5.21
73C	7	17.25	5.07	.46	2.56	.60	.25	1.50	5/8 to 3/4	.43	5.21
74C	7	19.75	5.81	.57	2.67	.60	.25	1.63	5/8 to 3/4	.42	5.21
60C	6	8.00	2.35	.20	1.92	.49	.20	1.06	1/2	.35	4.52
61C	6	10.50	3.09	.27	2.14	.53	.22	1.25	1/2 to 5/8	.37	4.39
62C	6	13.00	3.82	.40	2.27	.53	.22	1.38	1/2 to 5/8	.37	4.39
63C	6	15.50	4.56	.52	2.39	.53	.22	1.50	1/2 to 5/8	.37	4.39
50C	5	6.50	1.91	.19	1.75	.45	.19	1.06	1/2	.31	3.61
51C	5	9.00	2.65	.32	1.88	.45	.19	1.19	1/2	.31	3.61
52C	5	11.50	3.38	.47	2.03	.45	.19	1.31	1/2	.31	3.61
40C	4	5.25	1.54	.18	1.58	.41	.18	0.94	3/8	.29	2.70
41C	4	6.25	1.84	.24	1.64	.41	.18	1.00	3/8	.29	2.70
42C	4	7.25	2.13	.32	1.72	.41	.18	1.06	3/8	.29	2.70
30C	3	4.00	1.18	.17	1.41	.38	.17	0.81	3/8	.27	1.79
31C	3	5.00	1.47	.25	1.49	.38	.17	0.88	3/8	.27	1.79
32C	3	6.00	1.76	.35	1.59	.38	.17	1.00	3/8	.27	1.79

For 2¼″, 2″ and 1¾″ channels, see plate 18.

PENCOYD Z BARS.

Nominal Size in Inches.	Section Number.	Actual Size in Inches for a Variation of $\frac{1}{16}$ Inch in Thickness.				Areas in Square Inches.	Weight per Foot in Pounds.	Increased Thickness in Inches for each Additional Pound per Foot.
		Flange.	Web.	Flange.	Thickness.			
3	30Z	2.62	3.00	2.62	.25	1.94	6.60	.037
3	31Z	2.69	3.06	2.69	.31	2.44	8.29	
3	32Z	2.75	3.12	2.75	.37	2.94	10.00	
3	33Z	2.66	3.00	2.66	.44	3.25	11.15	.039
3	34Z	2.69	3.03	2.69	.47	3.51	11.93	
3	35Z	2.72	3.06	2.72	.50	3.75	12.75	
4	40Z	2.87	4.00	2.87	.25	2.32	7.88	.031
4	41Z	2.94	4.06	2.94	.31	2.91	9.89	
4	42Z	3.00	4.12	3.00	.37	3.52	11.90	
4	43Z	2.97	4.00	2.97	.44	3.96	13.46	.031
4	44Z	3.03	4.06	3.03	.50	4.56	15.50	
4	45Z	3.09	4.12	3.09	.56	5.16	17.54	
4	46Z	3.06	4.00	3.06	.62	5.55	18.80	.030
4	47Z	3.12	4.06	3.12	.68	6.14	20.87	
4	48Z	3.19	4.12	3.19	.75	6.75	22.95	
5	50Z	3.19	5.00	3.19	.31	3.36	11.42	.026
5	51Z	3.25	5.06	3.25	.37	4.05	13.77	
5	52Z	3.31	5.12	3.31	.44	4.75	16.15	
5	53Z	3.22	5.00	3.22	.50	5.23	17.78	.027
5	54Z	3.28	5.06	3.28	.56	5.91	20.09	
5	55Z	3.34	5.12	3.34	.62	6.60	22.44	
5	56Z	3.25	5.00	3.25	.68	6.96	23.66	.027
5	57Z	3.31	5.06	3.31	.75	7.64	25.97	
6	60Z	3.50	6.00	3.50	.37	4.59	15.61	.023
6	61Z	3.56	6.06	3.56	.44	5.39	18.32	
6	62Z	3.62	6.12	3.62	.50	6.19	21.05	
6	63Z	3.50	6.00	3.50	.56	6.68	22.71	.023
6	64Z	3.56	6.06	3.56	.62	7.46	25.36	
6	65Z	3.62	6.12	3.62	.69	8.25	28.05	
6	66Z	3.50	6.00	3.50	.75	8.64	29.37	.025
6	67Z	3.56	6.06	3.56	.81	9.38	31.89	
6	68Z	3.62	6.12	3.62	.87	10.16	34.54	

(For Rivet Spacing, see page 260.)

PENCOYD ANGLES.

EVEN LEGS.

Dimensions in inches. Weight in pounds.

Section Number.	Size.	Thickness.	Weight per Foot.	Area of Section.
880A	8 x 8	1/2	26.4	7.76
881A	8 x 8	9/16	29.8	8.76
882A	8 x 8	5/8	33.2	9.76
883A	8 x 8	11/16	36.6	10.76
884A	8 x 8	3/4	39.0	11.47
885A	8 x 8	13/16	42.4	12.47
886A	8 x 8	7/8	45.8	13.47
887A	8 x 8	15/16	49.3	14.50
888A	8 x 8	1	52.8	15.53
660A	6 x 6	3/8	14.8	4.35
661A	6 x 6	7/16	17.3	5.09
662A	6 x 6	1/2	19.7	5.79
663A	6 x 6	9/16	22.0	6.47
664A	6 x 6	5/8	24.4	7.18
665A	6 x 6	11/16	26.5	7.79
666A	6 x 6	3/4	28.8	8.47
667A	6 x 6	13/16	31.0	9.12
668A	6 x 6	7/8	33.4	9.82
669A	6 x 6	15/16	35.9	10.56
550A	5 x 5	3/8	12.3	3.62
551A	5 x 5	7/16	14.3	4.21
552A	5 x 5	1/2	16.3	4.79
553A	5 x 5	9/16	18.2	5.35
554A	5 x 5	5/8	20.1	5.91
555A	5 x 5	11/16	22.0	6.47
556A	5 x 5	3/4	23.8	7.00
557A	5 x 5	13/16	25.6	7.53
558A	5 x 5	7/8	27.4	8.06
559A	5 x 5	15/16	29.4	8.65
440A	4 x 4	5/16	8.2	2.41
441A	4 x 4	3/8	9.8	2.88
442A	4 x 4	7/16	11.3	3.32
443A	4 x 4	1/2	12.8	3.76
444A	4 x 4	9/16	14.5	4.21
445A	4 x 4	5/8	15.8	4.65
446A	4 x 4	11/16	17.2	5.06
447A	4 x 4	3/4	18.6	5.47
350A	3 1/2 x 3 1/2	5/16	7.1	2.09
351A	3 1/2 x 3 1/2	3/8	8.5	2.50
352A	3 1/2 x 3 1/2	7/16	9.8	2.88
353A	3 1/2 x 3 1/2	1/2	11.1	3.26
354A	3 1/2 x 3 1/2	9/16	12.4	3.65
355A	3 1/2 x 3 1/2	5/8	13.7	4.03

The length of leg is nominal, and correct only for least thickness.

PENCOYD ANGLES.

EVEN LEGS.

Dimensions in inches. Weight in pounds.

Section Number.	Size.	Thickness.	Weight per Foot.	Area of Section.	Section Number.	Size.	Thickness.	Weight per Foot.	Area of Section.
330A	3 x 3	1/4	4.9	1.44	220A	2 x 2	3/16	2.5	0.74
331A	3 x 3	5/16	6.1	1.79	221A	2 x 2	1/4	3.2	0.94
332A	3 x 3	3/8	7.2	2.12	222A	2 x 2	5/16	4.0	1.18
333A	3 x 3	7/16	8.3	2.44	223A	2 x 2	3/8	4.8	1.41
334A	3 x 3	1/2	9.4	2.76					
335A	3 x 3	9/16	10.4	3.06					
336A	3 x 3	5/8	11.5	3.38	175A	1 3/4 x 1 3/4	3/16	2.1	0.62
					176A	1 3/4 x 1 3/4	1/4	2.8	0.82
					177A	1 3/4 x 1 3/4	5/16	3.5	1.03
275A	2 3/4 x 2 3/4	1/4	4.5	1.32	178A	1 3/4 x 1 3/4	3/8	4.1	1.21
276A	2 3/4 x 2 3/4	5/16	5.5	1.62					
277A	2 3/4 x 2 3/4	3/8	6.6	1.94					
278A	2 3/4 x 2 3/4	7/16	7.7	2.26	150A	1 1/2 x 1 1/2	1/8	1.2	0.35
279A	2 3/4 x 2 3/4	1/2	8.6	2.53	151A	1 1/2 x 1 1/2	3/16	1.8	0.53
					152A	1 1/2 x 1 1/2	1/4	2.4	0.71
250A	2 1/2 x 2 1/2	3/16	3.1	0.91	153A	1 1/2 x 1 1/2	5/16	2.9	0.85
251A	2 1/2 x 2 1/2	1/4	4.1	1.21	154A	1 1/2 x 1 1/2	3/8	3.5	1.03
252A	2 1/2 x 2 1/2	5/16	5.0	1.47					
253A	2 1/2 x 2 1/2	3/8	5.9	1.74	125A	1 1/4 x 1 1/4	1/8	1.0	0.29
254A	2 1/2 x 2 1/2	7/16	6.9	2.03	126A	1 1/4 x 1 1/4	3/16	1.5	0.44
255A	2 1/2 x 2 1/2	1/2	7.8	2.29	127A	1 1/4 x 1 1/4	1/4	2.0	0.59
225A	2 1/4 x 2 1/4	3/16	2.7	0.79					
226A	2 1/4 x 2 1/4	1/4	3.6	1.06	110A	1 x 1	1/8	0.8	0.24
227A	2 1/4 x 2 1/4	5/16	4.5	1.32	111A	1 x 1	3/16	1.2	0.35
228A	2 1/4 x 2 1/4	3/8	5.4	1.59	112A	1 x 1	1/4	1.5	0.44

The length of leg is nominal, and correct only for least thickness.

PENCOYD ANGLES.

UNEVEN LEGS.

Dimensions in inches. Weight in pounds.

Section Number.	Size.	Thickness.	Weight per Foot.	Area of Section.
860A	8 x 6	½	23.0	6.76
861A	8 x 6	9/16	25.8	7.59
862A	8 x 6	⅝	28.7	8.44
863A	8 x 6	11/16	31.7	9.32
864A	8 x 6	¾	33.8	9.94
865A	8 x 6	13/16	36.6	10.76
866A	8 x 6	⅞	39.5	11.62
867A	8 x 6	15/16	42.5	12.50
868A	8 x 6	1	45.6	13.41
730A	7 x 3½	½	17.0	5.00
731A	7 x 3½	9/16	19.0	5.59
732A	7 x 3½	⅝	21.0	6.18
733A	7 x 3½	11/16	23.0	6.76
734A	7 x 3½	¾	24.8	7.29
735A	7 x 3½	13/16	26.7	7.85
736A	7 x 3½	⅞	28.6	8.41
737A	7 x 3½	15/16	30.5	8.97
738A	7 x 3½	1	32.5	9.56
650A	6½ x 4	⅜	12.9	3.79
651A	6½ x 4	7/16	15.0	4.41
652A	6½ x 4	½	17.0	5.00
653A	6½ x 4	9/16	19.0	5.59
654A	6½ x 4	⅝	21.2	6.24
655A	6½ x 4	11/16	23.4	6.88
656A	6½ x 4	¾	25.6	7.53
657A	6½ x 4	13/16	27.8	8.18
658A	6½ x 4	⅞	29.8	8.77
659A	6½ x 4	15/16	31.9	9.38
640A	6 x 4	⅜	12.2	3.59
641A	6 x 4	7/16	14.3	4.21
642A	6 x 4	½	16.3	4.79
643A	6 x 4	9/16	18.1	5.32
644A	6 x 4	⅝	20.1	5.91
645A	6 x 4	11/16	22.0	6.47
646A	6 x 4	¾	23.8	7.00

Section Number.	Size.	Thickness.	Weight per Foot.	Area of Section.
647A	6 x 4	13/16	25.6	7.53
648A	6 x 4	⅞	27.4	8.06
649A	6 x 4	15/16	29.4	8.65
630A	6 x 3½	⅜	11.6	3.41
631A	6 x 3½	7/16	13.6	4.00
632A	6 x 3½	½	15.5	4.56
633A	6 x 3½	9/16	17.1	5.03
634A	6 x 3½	⅝	19.0	5.59
635A	6 x 3½	11/16	20.8	6.12
636A	6 x 3½	¾	22.6	6.65
637A	6 x 3½	13/16	24.5	7.21
638A	6 x 3½	⅞	26.5	7.79
639A	6 x 3½	15/16	28.6	8.41
500A	5½ x 3½	⅜	11.0	3.24
501A	5½ x 3½	7/16	12.8	3.76
502A	5½ x 3½	½	14.6	4.29
503A	5½ x 3½	9/16	16.2	4.76
504A	5½ x 3½	⅝	17.9	5.26
540A	5 x 4	⅜	11.0	3.24
541A	5 x 4	7/16	12.8	3.76
542A	5 x 4	½	14.6	4.29
543A	5 x 4	9/16	16.2	4.76
544A	5 x 4	⅝	17.9	5.26
545A	5 x 4	11/16	19.6	5.76
546A	5 x 4	¾	21.3	6.26
510A	5 x 3½	5/16	8.7	2.56
511A	5 x 3½	⅜	10.3	3.03
512A	5 x 3½	7/16	12.0	3.53
513A	5 x 3½	½	13.6	4.00
514A	5 x 3½	9/16	15.2	4.47
515A	5 x 3½	⅝	16.8	4.94
516A	5 x 3½	11/16	18.4	5.41
517A	5 x 3½	¾	20.0	5.88

The length of leg is nominal, and correct only for least thickness.

PENCOYD ANGLES.

UNEVEN LEGS.

Dimensions in inches. Weight in pounds.

Section Number.	Size.	Thickness.	Weight per Foot.	Area of Section.
530A	5 x 3	5/16	8.2	2.41
531A	5 x 3	3/8	9.7	2.85
532A	5 x 3	7/16	11.2	3.29
533A	5 x 3	1/2	12.8	3.76
534A	5 x 3	9/16	14.2	4.18
535A	5 x 3	5/8	15.7	4.62
536A	5 x 3	11/16	17.2	5.06
537A	5 x 3	3/4	18.7	5.50
450A	4½ x 3	5/16	7.7	2.26
451A	4½ x 3	3/8	9.1	2.68
452A	4½ x 3	7/16	10.5	3.09
453A	4½ x 3	1/2	11.9	3.50
454A	4½ x 3	9/16	13.3	3.91
455A	4½ x 3	5/8	14.7	4.32
456A	4½ x 3	11/16	16.0	4.71
457A	4½ x 3	3/4	17.4	5.12
410A	4 x 3½	5/16	7.7	2.26
411A	4 x 3½	3/8	9.1	2.68
412A	4 x 3½	7/16	10.5	3.09
413A	4 x 3½	1/2	11.9	3.50
414A	4 x 3½	9/16	13.3	3.91
415A	4 x 3½	5/8	14.7	4.32
416A	4 x 3½	11/16	16.0	4.71
417A	4 x 3½	3/4	17.4	5.12
430A	4 x 3	5/16	7.1	2.09
431A	4 x 3	3/8	8.5	2.50
432A	4 x 3	7/16	9.8	2.88
433A	4 x 3	1/2	11.1	3.26
434A	4 x 3	9/16	12.4	3.65
435A	4 x 3	5/8	13.8	4.06
300A	3½ x 3	5/16	6.6	1.94
301A	3½ x 3	3/8	7.8	2.29
302A	3½ x 3	7/16	9.1	2.68
303A	3½ x 3	1/2	10.3	3.03
304A	3½ x 3	9/16	11.6	3.41
305A	3½ x 3	5/8	12.9	3.79

Section Number.	Size.	Thickness.	Weight per Foot.	Area of Section.
310A	3½ x 2½	1/4	4.9	1.44
311A	3½ x 2½	5/16	6.1	1.79
312A	3½ x 2½	3/8	7.2	2.12
313A	3½ x 2½	7/16	8.3	2.44
314A	3½ x 2½	1/2	9.4	2.76
316A	3½ x 2	1/4	4.5	1.32
317A	3½ x 2	5/16	5.5	1.62
318A	3½ x 2	3/8	6.6	1.94
325A	3 x 2½	1/4	4.5	1.32
326A	3 x 2½	5/16	5.5	1.62
327A	3 x 2½	3/8	6.6	1.94
328A	3 x 2½	7/16	7.7	2.26
329A	3 x 2½	1/2	8.7	2.56
320A	3 x 2	1/4	4.1	1.21
321A	3 x 2	5/16	5.0	1.47
322A	3 x 2	3/8	5.9	1.74
323A	3 x 2	7/16	6.9	2.03
324A	3 x 2	1/2	7.9	2.32
200A	2½ x 2	3/16	2.7	0.79
201A	2½ x 2	1/4	3.6	1.06
202A	2½ x 2	5/16	4.5	1.32
203A	2½ x 2	3/8	5.4	1.59
204A	2½ x 2	7/16	6.2	1.82
205A	2½ x 2	1/2	7.0	2.06
206A	2¼ x 1½	3/16	2.3	0.68
207A	2¼ x 1½	1/4	3.0	0.88
208A	2¼ x 1½	5/16	3.7	1.09
209A	2¼ x 1½	3/8	4.4	1.29
215A	2 x 1½	3/16	2.1	0.62
216A	2 x 1½	1/4	2.9	0.85
217A	2 x 1½	5/16	3.6	1.06
218A	2 x 1½	3/8	4.3	1.26
210A	2 x 1¼	3/16	1.9	0.56
211A	2 x 1¼	1/4	2.6	0.76
212A	2 x 1¼	5/16	3.3	0.97
213A	2 x 1¼	3/8	3.9	1.15

The length of leg is nominal, and correct only for least thickness.

PENCOYD ANGLES.

SQUARE ROOT ANGLES.

No. of Section.	Size in Inches.	*Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.*											
		1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8
		.125	.1875	.25	.3125	.375	.4375	.50	.5625	.625	.6875	.75	.875
40A	4 x 4					9.8	11.4	13.0	14.6	16.2			
35A	3½ x 3½				7.1	8.5	9.9	11.4					
30A	3 x 3			4.9	6.1	7.2	8.3	9.4					
28A	2¾ x 2¾			4.5	5.6	6.7	7.8	8.9					
25A	2½ x 2½			4.1	5.1	6.1	7.1	8.2					
24A	2¼ x 2¼			3.6	4.5	5.4							
20A	2 x 2			3.3	4.1	4.9							
18A	1¾ x 1¾			2.9	3.6	4.4							
15A	1½ x 1½		1.80	2.4	3.0								
12A	1¼ x 1¼		1.53	2.04	2.55								
10A	1 x 1	0.82	1.16	1.53									

ANGLE COVERS.

No. of Section.	Size in Inches.	*Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.*											
		1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8
		.125	.1875	.25	.3125	.375	.4375	.50	.5625	.625	.6875	.75	.875
33A	3 x 3			4.8	5.9	7.1	8.2	9.3	10.4	11.5			
27A	2¾ x 2¾			4.4	5.5	6.6	7.7	8.8					
26A	2½ x 2½		3.0	4.0	5.0	6.0	7.0	8.1					
23A	2¼ x 2¼		2.6	3.5	4.4	5.3							
22A	2 x 2		2.4	3.2	4.0	4.8							

SPECIAL ANGLES.

No. of Section.	Size in Inches.	*Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.*											
		1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8
		.125	.1875	.25	.3125	.375	.4375	.50	.5625	.625	.6875	.75	.875
278A	2⅞ x 2¼			4.2	5.3	6.4							
415A	4½ x 1½		3.6	4.9									

PENCOYD DECK BEAMS.

Depth in Inches.	*Section Numbers.*	*Minimum Flange Width in Inches.*	*Minimum Web Thickness in Inches.*	*Minimum Weight per Foot in Pounds.*	*Approximate Weight in Pounds per Foot for each Thickness of Web, in Inches.*								*Increased Thickness in Inches for each Additional Pound per Foot.*
					$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	
11½	115D	5.25	.406	32.2			33.4	35.8	38.2	40.7	43.1	45.6	.026
10	100D	5.25	.375	28.0		28.0	30.2	32.3	34.4	36.5	38.6		.029
9	90D	5.00	.375	25.0		25.0	26.9	28.8	30.7	32.6			.033
8	80D	4.62	.343	21.0		21.8	23.5	25.2	26.9	28.6			.037
7	70D	4.25	.343	18.0		18.5	20.0	21.5	23.0	24.5			.042
6	60D	3.75	.312	14.5	14.5	15.8	17.1	18.3	19.6				.049
5	50D	3.25	.312	11.5	11.5	12.5	13.6	14.7	15.8				.059

PENCOYD BULB ANGLES.

10	100A	3.62	.500	25.6				25.6	28.6	31.5			.022
9	90A	3.50	.484	22.5				23.2	26.0				.023
8	80A	3.37	.453	19.5				21.3	23.7				.026
7	70A	3.19	.406	16.0			17.1	19.2					.030
6	60A	3.00	.359	12.7		13.2	15.1	17.1	19.0				.033
5	50A	2.75	.312	9.7	9.7	11.4	13.0						.038

PENCOYD TEES.

For details see lithographs—Plates Nos. 23, 24, 25 and 26.

EVEN TEES.

Section Number.	*Size in Inches.*	*Weight per Foot.*
440T	4 x 4	10.9
441T	4 x 4	13.7
335T	3½ x 3½	7.0
336T	3½ x 3½	9.0
337T	3½ x 3½	11.0
330T	3 x 3	6.5
331T	3 x 3	7.7
225T	2½ x 2½	5.0
226T	2½ x 2½	5.8
227T	2½ x 2½	6.6
222T	2¼ x 2¼	4.0
223T	2¼ x 2¼	4.0
220T	2 x 2	3.5
117T	1¾ x 1¾	2.4
115T	1½ x 1½	2.0
112T	1¼ x 1¼	1.5
110T	1 x 1	1.0

UNEVEN TEES.

Section Number.	*Size in Inches.*	*Weight per Foot.*
64T	6 x 4	17.4
65T	6 x 5¼	39.0
53T	5 x 3½	17.0
54T	5 x 4	15.3
42T	4 x 2	6.5
43T	4 x 3	9.0
44T	4 x 3	10.2
45T	4 x 4½	13.5
38T	3½ x 3	7.0
39T	3½ x 3	8.5
30T	3 x 1½	4.0
31T	3 x 2½	5.0
32T	3 x 2½	6.0
33T	3 x 2½	7.0
34T	3 x 2½	8.0
35T	3 x 3½	8.3
36T	3 x 3½	9.5
28T	2¾ x 1¾	6.6
29T	2¾ x 2	7.2
25T	2½ x 1¼	3.3
26T	2½ x 2¾	5.7
27T	2½ x 3	6.0
24T	2¼ x $\frac{9}{16}$	2.2
20T	2 x $\frac{9}{16}$	2.0
22T	2 x $1\frac{1}{16}$	2.0
21T	2 x 1	2.5
23T	2 x 1½	3.0
17T	1¾ x $1\frac{1}{16}$	1.9
18T	1¾ x 1¼	3.5
15T	1½ x $\frac{15}{16}$	1.4
12T	1¼ x $\frac{15}{16}$	1.2

MISCELLANEOUS SHAPES.

Section Number.	*Section.*	*Size in Inches.*	*Weight per Foot in Pounds.*
217M	Heavy Rail.	6	50.0
210M	Floor Bars.	$3\frac{1}{16}$ x 4 x $3\frac{1}{16}$ x ¼ to ½	7.1 to 14.3
260M		2½ x 6 x 2½ x ¼ to ⅜	9.8 to 14.7

SIZES OF PENCOYD BARS.

FLATS.

7/8	x 3/8	inches to	3/4	inches.	2 5/32	x 1 3/8	inches to	2	inches.
1	x 1/4	"	7/8	"	2 1/4	x 1/4	"	1 7/8	"
1 1/32	x 1/2	"	1	"	2 5/16	x 1 1/2	"	2	"
1 1/16	x 1/2	"	1	"	2 3/8	x 5/8	"	1 3/4	"
1 1/8	x 1/4	"	1	"	2 1/2	x 1/4	"	1 3/4	"
1 3/16	x 5/8	"	1	"	2 3/4	x 1/4	"	7/8	"
1 7/32	x 1/2	"	1	"	3	x 1/4	"	2	"
1 1/4	x 1/4	"	1	"	3 1/4	x 1/4	"	7/8	"
1 5/16	x 5/8	"	1	"	3 1/2	x 1/4	"	7/8	"
1 3/8	x 1/4	"	1 1/4	"	4	x 1/4	"	2 1/2	"
1 13/32	x 5/8	"	1	"	4 1/2	x 1/4	"	7/8	"
1 7/16	x 11/16	"	1 1/8	"	5	x 1/4	"	2 1/2	"
1 1/2	x 1/4	"	1 1/4	"	6	x 1/4	"	2 1/2	"
1 19/32	x 3/4	"	1 1/4	"	7	x 1/4	"	2 1/2	"
1 5/8	x 1/4	"	1 1/2	"	8	x 1/4	"	2 1/2	"
1 3/4	x 1/4	"	1 1/4	"	9	x 1/4	"	2 3/4	"
1 31/32	x 5/8	"	1 3/4	"	10	x 1/4	"	2 1/2	"
2	x 1/4	"	1 1/2	"	12	x 1/4	"	2 1/2	"

ROUNDS.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/16, 1 1/8, 1 3/16, 1 1/4, 1 5/16, 1 3/8, 1 7/16, 1 1/2, 1 9/16, 1 5/8, 1 3/4, 1 7/8, 2, 2 1/8, 2 1/4, 2 3/8, 2 1/2, 2 5/8, 2 3/4, 2 7/8, 3, 3 1/8, 3 1/4, 3 3/8, 3 1/2, 3 5/8, 3 3/4, 3 7/8, 4, 4 1/8, 4 1/4, 4 3/8, 4 1/2, 4 5/8, 4 3/4, 4 7/8, 5, 5 1/4, 5 1/2, 5 3/4, 6, 6 1/2, 7 inches.

HALF ROUNDS.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/8, 1 1/4, 1 3/8, 1 1/2, 1 5/8, 1 3/4, 2, 2 1/4, 2 1/2, 3, 3 1/2, 4, 4 1/2 inches.

SQUARES.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/16, 1 1/8, 1 3/16, 1 1/4, 1 3/8, 1 1/2, 1 5/8, 1 3/4, 1 7/8, 2, 2 1/8, 2 1/4, 2 3/8, 2 1/2, 2 5/8, 2 3/4, 2 7/8, 3, 3 1/8, 3 1/4, 3 3/8, 3 1/2, 3 5/8, 3 3/4, 3 7/8, 4, 4 1/8, 4 1/4, 4 3/8, 4 1/2, 4 5/8, 4 3/4, 4 7/8, 5 inches.

RIVET SIZES.

30/64, 31/64, 33/64, 37/64, 38/64, 39/64, 41/64, 46/64, 47/64, 49/64, 53/64, 54/64, 55/64, 57/64, 61/64, 62/64, 63/64, 1 1/64, 1 5/64, 1 9/64, 1 13/64, 1 17/64 inches.

BOLT SIZES 1/64TH FULL.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/16, 1 1/8, 1 3/16, 1 1/4 inches.

OPEN-HEARTH STEEL AXLES.

Axles for locomotive and car service are made at Pencoyd of open-hearth steel, to conform to either the drop or mechanical test, as may be required.

The results below, taken as an average of a number of tests, represent the quality of material used for this purpose.

TRANSVERSE TEST.

Number of Axles.	*Diameter of Hub Seat.*	*Diameter of Centre.*	*Weight of Ram.*	*Height of Fall.*	*Number of Blows.*
14	$5\frac{1}{2}$	$4\frac{5}{8}$	1640	29	36
26	$5\frac{3}{16}$	$4\frac{3}{8}$	1640	25	37

TENSILE TEST.

	Elastic Limit.	*Ultimate Strength.*	*Elongation.*	*Reduction of Area.*
Average of 12 tests.	45320	79230	In 2″. 22.7 %	38 %

The blooms are worked at a single uniform heat, under heavy hammers, to the finished forging. Locomotive and passenger car-axles are furnished rough-turned throughout; those for freight service, with journals forged and rough-turned.

The process of manufacture thus indicated produces axles of the highest standard of excellence.

STRUCTURAL STEEL.

The strength of structural steel depends largely on the amount of the constituent elements that are associated with the iron, and each of which affect more or less the hardness and strength of the metal.

The principal of these are carbon, manganese, silicon, phosphorus and sulphur, the first-named being purposely retained as useful or necessary, the others being rejected, as far as practicable, as objectionable when in excess of certain minute proportions.

The grade and character of the steel is usually known by the percentage of contained carbon. Steel used in structures usually varies in tensile strength from 55,000 to 70,000 lbs. per square inch of section, or from .10 to .25 per cent. of carbon.

The following table exhibits the physical characteristics of Open-Hearth Basic Steel of the various grades, the results derived from an extensive series of tests indicating the tendency of a total average of the composition hereafter described to approximate to the figures given in table.

The predominant elements other than carbon averaged throughout the series as follows: manganese, .40; phosphorus, .04; sulphur, .05 per cent. Any increase of these elements is attended with an increase of tensile strength and reduced ductility, and vice versa. The tensile strength of the steel is also affected to some extent by the temperature at which it is finished, and the rate of cooling, these influences being more apparent in the grades containing highest carbon. Therefore the values given have only a general significance, and individual tests may vary widely above or below the figures in the table.

For Bessemer or open-hearth acid process steel, the tensile strength will ordinarily be greater for the same percentage of carbon given in this table, for the reason that the proportions of phosphorus and sulphur, and sometimes manganese, are usually higher than in open-hearth basic steel, each of these elements contributing to strength and hardness in the steel.

OPEN-HEARTH BASIC STEEL.

Percentage of Carbon.	*Tensile Strength in Pounds per Square Inch.*		*Ductility.*	
	Ultimate Strength.	*Elastic Limit.*	*Stretch in 8 Inches.*	*Reduction of Fractured Area.*
.08	54000	32500	32 per cent.	60 per cent.
.09	54800	33000	31 "	58 "
.10	55700	33500	31 "	57 "
.11	56500	34000	30 "	56 "
.12	57400	34500	30 "	55 "
.13	58200	35000	29 "	54 "
.14	59100	35500	29 "	53 "
.15	60000	36000	28 "	52 "
.16	60800	36500	28 "	51 "
.17	61600	37000	27 "	50 "
.18	62500	37500	27 "	49 "
.19	63300	38000	26 "	48 "
.20	64200	38500	26 "	47 "
.21	65000	39000	25 "	46 "
.22	65800	39500	25 "	45 "
.23	66600	40000	24 "	44 "
.24	67400	40500	24 "	43 "
.25	68200	41000	23 "	42 "

For convenient distinguishing terms, it is customary to classify steel in three grades: "mild or soft," "medium" and "hard," and although the different grades blend into each other, so that no line of distinction exists, in a general sense the grades below .15 carbon may be considered as "soft" steel, from .15 to .30 carbon as "medium," and above that "hard" steel. Each grade has its own advantages for the particular purpose to which it is adapted. The soft steel is well adapted for boiler plate and similar uses, where its high ductility is advantageous. The medium grades are used for general structural purposes, while harder steel is especially adapted for axles and shafts, and any service where good wearing surfaces are desired. Mild steel has superior welding property as compared to hard steel, and will endure higher heat without injury. Steel below .10 carbon should be capable of doubling flat without fracture, after being chilled from a red heat in cold water. Steel of

.15 carbon will occasionally submit to the same treatment, but will usually bend around a curve whose radius is equal to the thickness of the specimen; about 90 per cent. of specimens stand the latter bending test without fracture. As the steel becomes harder, its ability to endure this bending test becomes more exceptional, and when the carbon ratio becomes .20, little over twenty-five per cent. of specimens will stand the last-described bending test. Steel having about .40 per cent. carbon will usually harden sufficiently to cut soft iron and maintain an edge.

ELASTICITY.

As the material elongates or shortens under stress, the change of length is directly proportionate to the stress, and the material recovers its original length after removal of the stress, until the elastic limit is reached, when changes of length are no longer regular and permanent set takes place, or the destruction of the material has begun.

In good material the stress at elastic limit, for either tension or compression, is usually about six-tenths of the ultimate tenacity.

The ductility, under tensile stress, is usually measured by the total elongation in a given length, or by the percentage of reduction of the fractured area, or by both.

The elasticity is measured by the change of length under stress below the elastic limit of the material. The elasticity of the various grades of steel are practically uniform, that is, each material will exhibit a uniform change of length under uniform stress below the elastic limit; but, as the elastic limit of the higher grades is greater than that of the lower or softer grades, the former will elongate or shorten to a greater extent than the latter before its elasticity is injured. This property is expressed by a modulus, which for either material will average about 29,000,000 lbs. That is, if the change of length could be extended sufficiently, it would require 29,000,000 lbs. per square inch of section to double the original length under tensile strain, or to shorten the length one-half under compression. Therefore, steel will extend or shorten $\frac{1}{29000000}$ part of its normal length, for every pound per sectional inch in change of load.

RESILIENCE OF STEEL.

Resilience is the amount of work done to produce a certain deformation in material. It is usually measured in inch-pounds. The total resilience is the work done in causing rupture or maximum deformation. The elastic resilience is the work done when the material is strained to the elastic limit. The work done by a load applied gradually, up to the elastic limit, is equal to one-half the product of the final stress, by the extension, or other deformation. Above the elastic limit the extensions increasing in a greater ratio than the loads, the work is approximately equal to two thirds of the product of the maximum stress by the extension. When a load is applied instantaneously the momentary elastic deformation is twice that resulting from the same load applied gradually. If the load is applied with percussion, the work is denoted by the product of the weight into the total fall.

The modulus of elastic resilience, is the work done on one cubic inch of material by a load gradually applied to the elastic limit.

$$\text{Modulus of elastic resilience} = \frac{1}{2}\,\frac{\text{square of elastic limit,}}{\text{Modulus of Elasticity,}}$$

$$\text{or elastic resilience} = \begin{array}{c}\text{modulus of elastic resilience} \times \text{vol-}\\ \text{ume of material in cubic inches.}\end{array}$$

Taking 3 grades of steel—mild, medium and hard—and ascertaining their respective elastic limits to be 35,000, 45,000 and 55,000 lbs. per square inch of section, and each grade having equal moduli of elasticity, say 29,000,000 lbs.

The modulus of elastic resilience

For Mild Steel	= 21.1	inch-pounds.
For Medium Steel	= 34.9	" "
For Hard Steel	= 52.2	" "

Similarly the elastic resilience per cubic inch, or modulus of resilience of a rectangular beam supported at both ends and loaded at the middle, is

$$\frac{1}{18}\,\frac{\text{square of stress on extreme fibres at elastic limit.}}{\text{Modulus of Elasticity.}}$$

EXPANSION BY HEAT.

Soft steel or iron will extend about $\frac{1}{150000}$ part of its length for each degree F. of elevation of temperature. For a variation in temperature of 100 degrees F., the change in length will be about one inch in 125 feet.

SPECIFIC GRAVITY.

The specific gravity of steel varies according to the purity of the metal, and also according to the degree of condensation imparted by the process of rolling or forging.

As a rule, mild steel has a higher specific gravity than hard steel, and both are lower than perfectly pure iron, but about two per cent. higher than ordinary commercial iron. Structural steel in comparatively small sections having the composition denoted in the previous table of tensile strength, has the following specific gravity, corresponding to given carbon ratio:

Carbon, Per cent.	*Specific Gravity.*	*Weight per Cubic Foot in Pounds.*
.10	7.860	489.92
.20	7.858	489.80
.30	7.856	489.67

In the form of rolled beams and largest commercial sections the weight will be slightly less than this.

The tables in this book are all calculated on a basis of 489.6 lbs. per cubic foot, or the sectional area in square inches multiplied by 3.4 equals the weight in pounds per foot.

Tables for Pencoyd Beams.

The following tables for beams give the greatest safe loads in net tons, evenly distributed, including the weight of the beam. The results are obtained by the methods described on pages 182 to 187, and correspond to an extreme fibre stress of 16,000 lbs. per square inch of section, or approximately about one-half the elastic limit of the material, presuming that steel of the milder grades is used.

LIMITS FOR THE SAFE LOAD.

These loads are given as the greatest safe loads, and the beams are entirely reliable for them under ordinary conditions.

For the loads given in italics in the beam tables, the web of the beam should be stiffened at the end to prevent crippling, or the load should not exceed that calculated by the formula for Maximum Load in Tons given on page 187, and in the Tables of Elements of the several sections, pages 188 to 203.

If, however, the conditions of the service involve the introduction of forces not considered in the tables, the character of the load must be considered, and the mode of application of the same. If the load is suddenly applied, especially if accompanied by impact, the resulting dynamic stresses will not be expresed by formulæ which are derived from static consideration alone. Freedom from vibration, or excessive deflection has usually to be provided for, or the beam may be of considerable length without lateral support. In many such cases it may be necessary to take smaller loads for beams than those given in tables. In general, the following limitations of the tabulated safe loads will be proper for the specified conditions :

Character of Service.	*Greatest Safe Loads.*
Quiescent load, subject to little vibration, as in ordinary floors, etc., especially where beams are short.	As in tables.
Fluctuating loads, causing vibration, especially if the beams are long as compared to their depth.	One-fifth ($\frac{1}{5}$) less than the tables.
When loads are suddenly applied with slight impact, or exposed to vibration from machinery or rapidly moving loads.	One third ($\frac{1}{3}$) less than the tables.

The beams, if of considerable length, are supposed to be braced horizontally, and it is safest to limit the application of the tabular loads to beams whose lengths between lateral supports do not exceed twenty times the flange width.

Our experience has been that a beam without lateral support is more stable than is commonly supposed. In an open-webbed beam, the top flange acts as a simple strut, and is liable to lateral flexure when the unsupported length is considerable. But in a solid beam the parts in tension sustain the parts in compression, and prevent the buckling which would otherwise occur.

Experiments have shown a reduction of about one-third of the normal modulus of rupture when the length of the beam becomes 80 times its flange width. But as the long beam may suffer if exposed to accidental cross strains, we recommend the greatest safe load to be reduced in such a ratio for long beams that when the length is seventy times the flange width the greatest safe loads will be reduced one-half. This will give safe loads, corresponding to given lengths, as follows:

BEAMS WITHOUT LATERAL SUPPORT.

Length of Beam.	*Proportion of Tabular Load Forming Greatest Safe Load.*
20 times flange width.	Whole tabular load.
30 " " "	$\frac{9}{10}$ " "
40 " " "	$\frac{8}{10}$ " "
50 " " "	$\frac{7}{10}$ " "
60 " " "	$\frac{6}{10}$ " "
70 " " "	$\frac{5}{10}$ " "

DEFLECTION.

The tabular deflections are derived from the coefficients on pages 188 to 191, as described on page 187. If the load on the beam is reduced below that of the tables, the deflection will be less than that given in the tables, in the direct ratio of the loads.

The greatest safe load in the middle of the beam is exactly one-half ($\frac{1}{2}$) of the distributed load, and the deflection for the former will be eight-tenths ($\frac{8}{10}$) of the deflection corresponding to the distributed load as given in the tables. If the load is placed out of centre on the beam, it will bear the same ratio to the load at the centre that the square of half the span bears to the product of the segments of the beam formed by the position of the load.

Example.—A 15-inch No. 150B **I** beam, 16 feet between supports, will safely carry an evenly distributed load (by the tables) of 19.7 tons, and deflect under same .29 inches. The greatest safe load in the middle will be one-half the above, viz., 9.8 tons, and the resulting deflection $\frac{8}{10}$ of the former, or .23 inches.

If the weight is concentrated 3 feet out of centre, or 5 feet and 11 feet from the ends, then the square of half the span being 64, and the product of the segments being 55, the greatest safe load will be $\frac{9.8 \times 64}{55} = 11.4$ tons.

If a beam of above size and length is used without any lateral support, reduce the safe load in the ratio aforesaid. Thus the flange is 6.4 inches wide, and the length 30 times this; therefore the greatest safe load will be $\frac{9}{10}$ of the results in the example.

If beams are supported as described hereafter, the greatest safe loads and corresponding deflections will bear the given ratios to the tabulated loads and deflections, for the same length and section of beams.

Character of Beam.	*Greatest Safe Load.*	*Deflection.*
Fixed at one end, with the load concentrated at the other end.	One-eighth ($\frac{1}{8}$) part of the tabular load.	Three and one-fifth ($3\frac{1}{5}$) times the tabular deflection.
Fixed at one end, with the load uniformly distributed.	One-fourth ($\frac{1}{4}$) part of the tabular load.	Two and two-fifths ($2\frac{2}{5}$) times the tabular deflection.
Rigidly fixed at both ends, with a load in the middle of beam.	Same as the tabular load.	Four-tenths ($\frac{4}{10}$) of the tabular deflection.
Rigidly fixed at both ends, with the load uniformly distributed.	One and one-half ($1\frac{1}{2}$) times the tabular load.	Three-tenths ($\frac{3}{10}$) of the tabular deflection.
Continuous beam loaded in middle.	Same as the tabular load.	Four-tenths ($\frac{4}{10}$) of the tabular deflection.
Continuous beam load uniformly distributed.	One and one-half ($1\frac{1}{2}$) times the tabular load.	Three-tenths ($\frac{3}{10}$) of the tabular deflection.

BEAMS WITH FIXED ENDS.

By beams "rigidly fixed," as denoted in the previous table, we mean that the beam must be so securely fastened at both ends, by being built into solid masonry, or so firmly attached to an adjacent structure, that the connection would not be severed if the beam was exposed to its ultimate load. In this case the beam is of the same character as if continuous over several supports, or as if consisting of two cantilevers, the space between whose ends was spanned by a separate beam.

CONTINUOUS BEAMS.

If a beam is continuous over several supports, and is equally loaded on each span, the greatest safe loads and the resulting deflections on any intermediate span will be as given in the preceding table. But the end spans of such a beam, being only semi-continuous, must be either of a shorter span than the intermediates, or, if of the same length, the load must be diminished.

HORIZONTAL SHEARING OF BEAMS.

In beams of very short spans or beams with heavy loads concentrated near supports, when the bending moments will be small in comparison with the reactions at the supports, the beams may fail by longitudinal shearing.

The intensity of the longitudinal shear at any section is the product of the vertical shear for that section and the statical moment of the section included between the plane of shear and the extreme fibres, divided by the product of the moment of inertia of the beam section and the thickness of the beam at the section where the shear is considered. The liability to horizontal shearing will not occur in beams for the lengths and loads given in the tables.

The following table gives the lengths under which beams should be designed to resist longitudinal shear when uniformly loaded to produce a fibre strain of 16,000 pounds per square inch, and are based on a working shearing stress of 12,000 pounds per square inch.

Size of Beam in Inches.	*Length of Span in Feet.*	*Size of Beam in Inches.*	*Length of Span in Feet.*
24	9.0	8	4.3
20	7.3	7	3.9
18	6.9	6	3.7
15	6.0	5	3.0
12	5.6	4	2.6
10	5.0	3	2.1
9	4.8		

SPACING AND DEFLECTION OF BEAMS.

THE proper spacing of beams depends on the amount and character of load and the length of span. Permissible deflection as well as positive strength must be considered. If the load is motionless, and especially if the span is small in comparison with the depth of beam, it will be safe to proportion the beams for the "greatest safe loads," as in preceding tables.

If, on the contrary, the floors are subject to vibration, or the action of moving loads, and especially if the span is great in proportion to depth of beam, it becomes necessary to consider the deflection, which may become so great as to be a source of injury to the structure. It is considered good practice to limit the deflection to $\frac{1}{30}$ of an inch per foot of span, or the total deflection not to exceed $\frac{1}{360}$ part of the span. For **I** beams subjected to the loads given in the tables, this deflection occurs when the depth of the beam is about $\frac{1}{25}$ of the span, or, approximately, twice the depth of the beam in inches gives the span in feet, having a deflection of $\frac{1}{360}$.

The following tables indicate for each beam this limitation for deflection. Those in heavy type above the dark line deflect less, and those in fine type below the same line deflect more than $\frac{1}{360}$ of the span. If the spans are unusually long, it is best to reduce the deflection below this limit, and maintain the depth of the beam not less than $\frac{1}{20}$ of the span. It has been demonstrated that the greatest mass of people that can be packed on any floor will not exceed in weight 80 lbs. per square foot. The weight of the beams will depend on the span, for which see a general rule farther on.

Within the limits of practical spans for rolled **I** beams, it will be found that a floor is safe for a packed mass of people when the beams are not strained above the "greatest safe load" of the tables, under the following rating:

I beam joists with wooden floor = 100 lbs. per sq. foot.
Wooden floor and plastered ceilings = 110 " " "
4″ brick arches and concrete filling = 150 " " "

These figures represent the total weight of floor itself and the imposed load.

Floors proportioned as follows for given purposes will be satisfactory. The weight of the material may be included in the figures.

Character of Floor.	*Load per Square Foot.*
Lightest floors, plank covering, ...	100 lbs.
Lightest floors, brick arches, ...	150 "
Light warehouse floors, ...	200 "
Halls of audience, ...	200 "
Warehouses in which heavy pieces are moved, ...	250 "
Shop floors for light machinery, ...	250 "
Shop floors for heavy machinery, ...	300 to 500 lbs.

RULE FOR THE WEIGHT OF FLOOR BEAMS.

The following rule gives a close approximation to the actual weight of floor beams, when the beams are proportioned according to the tables.

$$\frac{\text{Load per sq. ft. in lbs.} \times \text{square of span in ft.}}{1000 \times \text{depth of beams in ins.}} = \text{lbs. of beams per sq. ft. of floor.}$$

Example.—A floor of 16 feet span bears 200 lbs. per sq. ft., required the weight of floor beams if 12″ beams are used.

$$\frac{200 \times 256}{1000 \times 12} = 4.3 \text{ lbs. per sq. ft. of beams.}$$

To the foregoing must be added the weight of the ends of the beams built into the supports, or a length at each end about the same as at the depth of the beam. The following table gives the weights of beams per square foot of floor, for a load of 100 lbs. per square foot, the beams, as in the preceding tables, subject to a stress of 16,000 lbs. per square inch. For greater floor loads the weight of beams increases in direct proportion. Thus, for a floor to carry 200 lbs. per square foot, the weight of floor beams will be twice that of the table. Also, if the floor beams are proportioned for a lower fibre stress, the weight of beams will increase in inverse ratio.

Thus, if the fibre strain allowed is 12,000 lbs. per square inch, the weight of beams will be increased as 12 to 16, or one-third heavier than the table.

PENCOYD I BEAMS.

LEAST WEIGHT OF FLOOR BEAMS IN POUNDS.

For each square foot of floor, including ends at supports, based on a load of 100 pounds per square foot of floor.

For heavier loads, the weights of beams are proportionately increased.

Size of I Beam Inches.	*Clear Span of Beams in Feet.*										
	8	10	12	14	16	18	20	22	24	26	28
	Least Weight of Floor Beams in Pounds.										
24		0.6	0.8	1.1	1.4	1.7	2.0	2.4	2.9	3.3	3.8
20		0.7	0.9	1.3	1.6	2.0	2.4	2.9	3.4	3.9	4.5
18		0.7	1.0	1.4	1.7	2.2	2.7	3.2	3.7	4.3	5.0
15		0.8	1.2	1.5	2.0	2.5	3.0	3.6	4.2	4.9	5.7
12	0.6	1.0	1.4	1.8	2.3	2.9	3.6	4.3	5.1	5.9	6.8
10	0.7	1.1	1.6	2.1	2.7	3.4	4.1	5.0	5.8	6.8	
9	0.8	1.2	1.7	2.3	2.9	3.7	4.5	5.3	6.4		
8	0.9	1.3	1.9	2.5	3.2	4.1	5.1	6.0	7.0		
7	1.0	1.5	2.1	2.9	3.7	4.7	5.7	6.9			
6	1.1	1.7	2.4	3.3	4.2	5.4	6.4				
5	1.3	2.0	2.9	4.0	5.1	6.4					

24″ I BEAM—No. 240 B.

80 POUNDS PER FOOT.

Flange width	7.00	Area in square inches	23.53
Web thickness.	.50	Resistance.	175.95

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*93.84*	.07	187.7	150.1	125.1	107.2
11	*85.31*	.09	155.1	124.1	103.4	88.6
12	*78.20*	.10	130.3	104.3	86.9	74.5
13	*72.18*	.12	111.0	88.8	74.0	63.5
14	*67.03*	.14	95.8	76.6	63.8	54.7
15	*62.56*	.16	83.4	66.7	55.6	47.7
16	*58.65*	.18	73.3	58.7	48.9	41.9
17	*55.20*	.21	64.9	52.0	43.3	37.1
18	*52.13*	.23	57.9	46.3	38.6	33.1
19	*49.39*	.26	52.0	41.6	34.7	29.7
20	*46.92*	.29	46.9	37.5	31.3	26.8
21	*44.69*	.31	42.6	34.0	28.4	24.3
22	*42.65*	.35	38.8	31.0	25.8	22.2
23	*40.80*	.38	35.5	28.4	23.7	20.3
24	*39.10*	.41	32.6	26.1	21.7	18.6
25	37.54	.45	30.0	24.0	20.0	17.2
26	36.09	.48	27.8	22.2	18.5	15.9
27	34.76	.52	25.7	20.6	17.2	14.7
28	33.51	.56	23.9	19.1	16.0	13.7
29	32.36	.60	22.3	17.9	14.9	12.8
30	31.28	.64	20.9	16.7	13.9	11.9
31	30.27	.69	19.5	15.6	13.0	11.2
32	29.33	.73	18.3	14.7	12.2	10.5
33	28.44	.78	17.2	13.8	11.5	9.8

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

24″ I BEAM—No. 241 B.

85 POUNDS PER FOOT.

Flange width	7.06	Area in square inches	25.00
Web thickness	.56	Resistance	181.81

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*96.96*	.07	193.9	155.1	129.3	110.8
11	*88.15*	.09	160.3	128.2	106.8	91.6
12	*80.80*	.10	134.7	107.7	89.8	77.0
13	*74.58*	.12	114.7	91.8	76.5	65.6
14	*69.26*	.14	98.9	79.2	66.0	56.5
15	*64.64*	.16	86.2	68.9	57.5	49.2
16	*60.60*	.18	75.8	60.6	50.5	43.3
17	*57.03*	.21	67.1	53.7	44.7	38.3
18	*53.87*	.23	59.9	47.9	39.9	34.2
19	*51.03*	.26	53.7	43.0	35.8	30.7
20	48.48	.29	48.5	38.8	32.3	27.7
21	46.17	.31	44.0	35.2	29.3	25.1
22	44.07	.35	40.1	32.1	26.7	22.9
23	42.16	.38	36.7	29.3	24.4	21.0
24	40.40	.41	33.7	26.9	22.4	19.2
25	38.79	.45	31.0	24.8	20.7	17.7
26	37.29	.48	28.7	22.9	19.1	16.4
27	35.91	.52	26.6	21.3	17.7	15.2
28	34.63	.56	24.7	19.8	16.5	14.1
29	33.44	.60	23.1	18.5	15.4	13.2
30	32.32	.64	21.5	17.2	14.4	12.3
31	31.28	.69	20.2	16.1	13.5	11.5
32	30.30	.73	18.9	15.2	12.6	10.8
33	29.38	.78	17.8	14.3	11.9	10.2

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

24″ I BEAM—No. 242 B.

90 POUNDS PER FOOT.

Flange width . . . . 7.42 | Area in square inches 26.47
Web thickness. . . . . 0.56 | Resistance 196.4

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*104.74*	.07	209.5	167.6	139.7	119.7
11	*95.22*	.09	173.1	138.5	115.4	98.9
12	*87.29*	.10	145.5	116.4	97.0	83.1
13	*80.57*	.12	124.0	99.2	82.6	70.8
14	*74.82*	.14	106.9	85.5	71.3	61.1
15	*69.83*	.16	93.1	74.5	62.1	53.2
16	*65.47*	.18	81.8	65.5	54.6	46.8
17	*61.61*	.21	72.5	58.0	48.3	41.4
18	*58.19*	.23	64.7	51.7	43.1	36.9
19	*55.13*	.26	58.0	46.4	38.7	33.2
20	*52.37*	.29	52.4	41.9	34.9	29.9
21	*49.88*	.31	47.5	38.0	31.7	27.1
22	47.61	.35	43.3	34.6	28.8	24.7
23	45.54	.38	39.6	31.7	26.4	22.6
24	43.64	.41	36.4	29.1	24.2	20.8
25	41.90	.45	33.5	26.8	22.3	19.1
26	40.29	.48	31.0	24.8	20.7	17.7
27	38.79	.52	28.7	23.0	19.2	16.4
28	37.41	.56	26.7	21.4	17.8	15.3
29	36.12	.60	24.9	19.9	16.6	14.2
30	34.92	.64	23.3	18.6	15.5	13.3
31	33.79	.69	21.8	17.4	14.5	12.5
32	32.73	.73	20.5	16.4	13.6	11.7
33	31.74	.78	19.2	15.4	12.8	11.0

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in columns XV, pages 188 to 191.

24″ I BEAM—No. 243 B.

95 POUNDS PER FOOT.

Flange width	7.48	Area in square inches	27.92
Web thickness	0.62	Resistance	202.3

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.* 100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*107.87*	.07	215.7	172.6	143.8	123.3
11	*98.06*	.09	178.3	142.6	118.9	101.9
12	*89.89*	.10	149.8	119.9	99.9	85.6
13	*82.98*	.12	127.7	102.1	85.1	73.0
14	*77.05*	.14	110.1	88.1	73.4	62.9
15	*71.91*	.16	95.9	76.7	63.9	54.8
16	*67.42*	.18	84.3	67.4	56.2	48.2
17	*63.45*	.21	74.6	59.7	49.8	42.7
18	*59.93*	.23	66.6	53.3	44.4	38.1
19	56.77	.26	59.8	47.8	39.8	34.3
20	53.93	.29	53.9	43.1	36.0	30.8
21	51.37	.31	48.9	39.2	32.6	28.0
22	49.03	.35	44.6	35.7	29.7	25.5
23	46.90	.38	40.8	32.6	27.2	23.3
24	44.94	.41	37.5	30.0	25.0	21.4
25	43.15	.45	34.5	27.6	23.0	19.7
26	41.49	.48	31.9	25.5	21.3	18.2
27	39.95	.52	29.6	23.7	19.7	16.9
28	38.52	.56	27.5	22.0	18.3	15.7
29	37.20	.60	25.7	20.5	17.1	14.7
30	35.96	.64	24.0	19.2	16.0	13.7
31	34.80	.69	22.5	18.0	15.0	12.8
32	33.71	.73	21.1	16.9	14.0	12.0
33	32.69	.78	19.8	15.9	13.2	11.3

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

24″ I BEAM—No. 244 B.

100 POUNDS PER FOOT.

Flange width . . . . 7.54 | Area in square inches 29.42
Web thickness. . . . . 0.68 | Resistance 208.1

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*110.99*	.07	222.0	177.6	148.0	126.8
11	*100.90*	.09	183.5	146.8	122.3	104.8
12	*92.49*	.10	154.2	123.3	102.8	88.1
13	*85.38*	.12	131.4	105.1	87.6	75.1
14	*79.28*	.14	113.3	90.6	75.5	64.7
15	*73.99*	.16	98.7	78.9	65.8	56.4
16	69.37	.18	86.7	69.4	57.8	49.6
17	65.29	.21	76.8	61.5	51.2	43.9
18	61.66	.23	68.5	54.8	45.7	39.1
19	58.42	.26	61.5	49.2	41.0	35.1
20	55.50	.29	55.5	44.4	37.0	31.7
21	52.85	.31	50.3	40.3	33.6	28.8
22	50.45	.35	45.9	36.7	30.6	26.2
23	48.26	.38	42.0	33.6	28.0	24.0
24	46.25	.41	38.5	30.8	25.7	22.0
25	44.40	.45	35.5	28.4	23.7	20.3
26	42.69	.48	32.8	26.3	21.9	18.8
27	41.11	.52	30.5	24.4	20.3	17.4
28	39.64	.56	28.3	22.7	18.9	16.2
29	38.27	.60	26.4	21.1	17.6	15.1
30	37.00	.64	24.7	19.7	16.5	14.1
31	35.80	.69	23.1	18.5	15.4	13.2
32	34.68	.73	21.7	17.3	14.5	12.4
33	33.63	.78	20.4	16.3	13.6	11.6

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

20″ I BEAM—No. 200 B.

65 POUNDS PER FOOT.

Flange width. . . . . 6.25 | Area in square inches 19.12
Web thickness . . . . .50 | Resistance 117.97

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*62.92*	.09	125.8	100.7	83.9	71.9
11	*57.20*	.10	104.0	83.2	69.3	59.4
12	*52.43*	.12	87.4	69.9	58.3	49.9
13	*48.40*	.14	74.5	59.6	49.6	42.6
14	*44.94*	.17	64.2	51.3	42.8	36.7
15	*41 95*	.19	55.9	44.7	37.3	32.0
16	*39.33*	.22	49.2	39.3	32.8	28.1
17	37.01	.25	43.5	34.8	29.0	24.9
18	34.95	.28	38.8	31.1	25.9	22.2
19	33.11	.31	34.9	27.9	23.2	19.9
20	31.46	.34	31.5	25.2	21.0	18.0
21	29.96	.38	28.5	22.8	19.0	16.3
22	28.60	.41	26.0	20.8	17.3	14.9
23	27.36	.45	23.8	19.0	15.9	13.6
24	26.22	.49	21.9	17.5	14.6	12.5
25	25.17	.54	20.1	16.1	13.4	11.5
26	24.20	.58	18.6	14.9	12.4	10.6
27	23.30	.62	17.3	13.8	11.5	9.9
28	22.47	.67	16.1	12.8	10.7	9.2
29	21.70	.72	15.0	12.0	10.0	8.6
30	20.97	.77	14.0	11.2	9.3	8.0
31	20.30	.82	13.1	10.5	8.7	7.5
32	19.66	.88	12.3	9.8	8.2	7.0
33	19.07	.93	11.6	9.2	7.7	6.6

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

20″ I BEAM—No. 201 B.

70 POUNDS PER FOOT.

Flange width	6.31	Area in square inches	20.59
Web thickness	0.56	Resistance	122.90

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*65.55*	.09	131.1	104.9	87.4	74.9
11	*59.59*	.10	108.3	86.7	72.2	61.9
12	*54.63*	.12	91.1	72.8	60.7	52.0
13	*50.42*	.14	77.6	62.1	51.7	44.3
14	46.82	.17	66.9	53.5	44.6	38.2
15	43.70	.19	58.3	46.6	38.8	33.3
16	40.97	.22	51.2	41.0	34.1	29.3
17	38.56	.25	45.4	36.3	30.2	25.9
18	36.42	.28	40.5	32.4	27.0	23.1
19	34.50	.31	36.3	29.1	24.2	20.8
20	32.78	.34	32.8	26.2	21.9	18.7
21	31.21	.38	29.7	23.8	19.8	17.0
22	29.80	.41	27.1	21.7	18.1	15.5
23	28.50	.45	24.8	19.8	16.5	14.2
24	27.31	.49	22.8	18.2	15.2	13.0
25	26.22	.54	21.0	16.8	14.0	12.0
26	25.21	.58	19.4	15.5	12.9	11.1
27	24.28	.62	18.0	14.4	12.0	10.3
28	23.41	.67	16.7	13.4	11.1	9.6
29	22.60	.72	15.6	12.5	10.4	8.9
30	21.85	.77	14.6	11.7	9.7	8.3
31	21.14	.82	13.6	10.9	9.1	7.8
32	20.48	.88	12.8	10.2	8.5	7.3
33	19.86	.93	12.0	9.6	8.0	6.9

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in columns XV, pages 188 to 191.

20″ I BEAM—No. 202 B.

75 POUNDS PER FOOT.

Flange width	6.39	Area in square inches . . .	22.06
Web thickness.	0.64	Resistance.	127.77

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*68.15*	.09	136.3	109.0	90.9	77.9
11	*61.95*	.10	112.6	90.1	75.1	64.4
12	56.79	.12	94.7	75.7	63.1	54.1
13	52.42	.14	80.7	64.5	53.8	46.1
14	48.68	.17	69.5	55.6	46.4	39.7
15	45.43	.19	60.6	48.5	40.4	34.6
16	42.59	.22	53.2	42.6	35.5	30.4
17	40.08	.25	47.2	37.7	31.4	26.9
18	37.86	.28	42.1	33.7	28.0	24.0
19	35.87	.31	37.7	30.2	25.2	21.6
20	34.07	.34	34.1	27.3	22.7	19.5
21	32.45	.38	30.9	24.7	20.6	17.7
22	30.98	.41	28.2	22.5	18.8	16.1
23	29.63	.45	25.8	20.6	17.2	14.7
24	28.39	.49	23.7	18.9	15.8	13.5
25	27.26	.54	21.8	17.4	14.5	12.5
26	26.21	.58	20.2	16.1	13.4	11.5
27	25.24	.62	18.7	15.0	12.5	10.7
28	24.33	.67	17.4	13.9	11.6	9.9
29	23.50	.72	16.2	13.0	10.8	9.3
30	22.72	.77	15.1	12.1	10.1	8.7
31	21.98	.82	14.2	11.3	9.5	8.1
32	21.30	.88	13.3	10.7	8.9	7.6
33	20.65	.93	12.5	10.0	8.3	7.2

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

20″ I BEAM—No. 203 B.

80 POUNDS PER FOOT.

Flange width . . . . 6.75 | Area in square inches 23.53
Web thickness. . . . . 0.63 | Resistance 140.44

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*74.90*	.09	149.8	119.8	99.9	85.6
11	*68.09*	.10	123.8	99.0	82.5	70.7
12	*62.42*	.12	104.0	83.2	69.4	59.4
13	57.62	.14	88.6	70.9	59.1	50.7
14	53.50	.17	76.4	61.1	51.0	43.7
15	49.93	.19	66.6	53.3	44.4	38.0
16	46.81	.22	58.5	46.8	39.0	33.4
17	44.06	.25	51.8	41.5	34.6	29.6
18	41.61	.28	46.2	37.0	30.8	26.4
19	39.42	.31	41.5	33.2	27.7	23.7
20	37.45	.34	37.5	30.0	25.0	21.4
21	35.67	.38	34.0	27.2	22.6	19.4
22	34.05	.41	31.0	24.8	20.6	17.7
23	32.57	.45	28.3	22.7	18.9	16.2
24	31.21	.49	26.0	20.8	17.3	14.9
25	29.96	.54	24.0	19.2	16.0	13.7
26	28.81	.58	22.2	17.7	14.8	12.7
27	27.74	.62	20.5	16.4	13.7	11.7
28	26.75	.67	19.1	15.3	12.7	10.9
29	25.83	.72	17.8	14.3	11.9	10.2
30	24.97	.77	16.6	13.3	11.1	9.5
31	24.16	.82	15.6	12.5	10.4	8.9
32	23.41	.88	14.6	11.7	9.8	8.4
33	22.70	.93	13.8	11.0	9.2	7.9

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

20″ I BEAM—No. 204 D.

85 POUNDS PER FOOT.

Flange width . . . . 6.82 | Area in square inches 25.00
Web thickness . . . . 0.70 | Resistance 145.31

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*77.50*	.09	155.0	124.0	103.3	88.6
11	70.45	.10	128.1	102.5	85.4	73.2
12	64.58	.12	107.6	86.1	71.8	61.5
13	59.61	.14	91.7	73.4	61.1	52.4
14	55.36	.17	79.1	63.3	52.7	45.2
15	51.67	.19	68.9	55.1	45.9	39.4
16	48.44	.22	60.6	48.4	40.4	34.6
17	45.59	.25	53.6	42.9	35.8	30.6
18	43.06	.28	47.8	38.3	31.9	27.3
19	40.79	.31	42.9	34.4	28.6	24.5
20	38.75	.34	38.8	31.0	25.8	22.1
21	36.90	.38	35.1	28.1	23.4	20.1
22	35.23	.41	32.0	25.6	21.4	18.3
23	33.69	.45	29.3	23.4	19.5	16.7
24	32.29	.49	26.9	21.5	17.9	15.4
25	31.00	.54	24.8	19.8	16.5	14.2
26	29.81	.58	22.9	18.3	15.3	13.1
27	28.70	.62	21.3	17.0	14.2	12.2
28	27.68	.67	19.8	15.8	13.2	11.3
29	26.72	.72	18.4	14.7	12.3	10.5
30	25.83	.77	17.2	13.8	11.5	9.8
31	25.00	.82	16.1	12.9	10.8	9.2
32	24.22	.88	15.1	12.1	10.1	8.7
33	23.48	.93	14.2	11.4	9.5	8.1

N. B.—For load given in Italics web must be stiffened, or load must not exceed maximum load given in column XV, pages 188 to 191.

20″ I BEAM—No. 205 B.

90 POUNDS PER FOOT.

Flange width. . . . . 6.90 | Area in square inches. 26.47
Web thickness . . . . 0.78 | Resistance 150.17

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	80.09	.09	160.2	128.1	106.8	91.5
11	72.81	.10	132.4	105.9	88.3	75.7
12	66.74	.12	111.2	89.0	74.2	63.6
13	61.61	.14	94.8	75.8	63.2	54.2
14	57.21	.17	81.7	65.4	54.5	46.7
15	53.39	.19	71.2	57.0	47.5	40.7
16	50.06	.22	62.6	50.1	41.7	35.8
17	47.11	.25	55.4	44.3	37.0	31.7
18	44.50	.28	49.4	39.6	33.0	28.3
19	42.15	.31	44.4	35.5	29.6	25.4
20	40.05	.34	40.1	32.0	26.7	22.9
21	38.14	.38	36.3	29.1	24.2	20.8
22	36.41	.41	33.1	26.5	22.1	18.9
23	34.82	.45	30.3	24.2	20.2	17.3
24	33.37	.49	27.8	22.2	18.5	15.9
25	32.04	.54	25.6	20.5	17.1	14.6
26	30.80	.58	23.7	19.0	15.8	13.5
27	29.66	.62	22.0	17.6	14.6	12.6
28	28.60	.67	20.4	16.3	13.6	11.7
29	27.62	.72	19.0	15.2	12.7	10.9
30	26.70	.77	17.8	14.2	11.9	10.2
31	25.84	.82	16.7	13.3	11.1	9.5
32	25.03	.88	15.6	12.5	10.4	8.9
33	24.27	.93	14.7	11.8	9.8	8.4

20″ I BEAM—No. 206 B.

95 POUNDS PER FOOT.

Flange width	7.24	Area in square inches	27.94
Web thickness	0.74	Resistance	160.19

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*86.41*	.09	172.8	138.3	115.2	98.8
11	78.55	.10	142.8	114.3	95.2	81.6
12	72.00	.12	120.0	96.0	80.0	68.6
13	66.47	.14	102.3	81.8	68.2	58.4
14	61.72	.17	88.2	70.5	58.8	50.4
15	57.60	.19	76.8	61.4	51.2	43.9
16	54.00	.22	67.5	54.0	45.0	38.6
17	50.83	.25	59.8	47.8	39.9	34.2
18	48.00	.28	53.3	42.7	35.6	30.5
19	45.48	.31	47.9	38.3	31.9	27.4
20	43.20	.34	43.2	34.6	28.8	24.7
21	41.15	.38	39.2	31.4	26.1	22.4
22	39.28	.41	35.7	28.6	23.8	20.4
23	37.57	.45	32.7	26.1	21.8	18.7
24	36.00	.49	30.0	24.0	20.0	17.1
25	34.56	.54	27.6	22.1	18.4	15.8
26	33.23	.58	25.6	20.5	17.0	14.6
27	32.00	.62	23.7	19.0	15.8	13.5
28	30.86	.67	22.0	17.6	14.7	12.6
29	29.79	.72	20.5	16.4	13.7	11.7
30	28.80	.77	19.2	15.4	12.8	11.0
31	27.87	.82	18.0	14.4	12.0	10.3
32	27.00	.88	16.9	13.5	11.3	9.6
33	26.18	.93	15.9	12.7	10.6	9.1

N. B.—For load given in Italics web must be stiffened, or load must not exceed maximum load given in column XV, page 189.

20″ I BEAM—No. 207 B.

100 POUNDS PER FOOT.

Flange width	7.31	Area in square inches	29.41
Web thickness	0.81	Resistance	164.96

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	88.98	.09	178.0	142.4	118.6	101.7
11	80.89	.10	147.1	117.7	98.0	84.1
12	74.15	.12	123.6	98.9	82.4	70.6
13	68.44	.14	105.3	84.2	70.2	60.2
14	63.56	.17	90.8	72.6	60.5	51.9
15	59.32	.19	79.1	63.3	52.7	45.2
16	55.61	.22	69.5	55.6	46.3	39.7
17	52.34	.25	61.6	49.3	41.1	35.2
18	49.43	.28	54.9	43.9	36.6	31.4
19	46.83	.31	49.3	39.4	32.9	28.2
20	44.49	.34	44.5	35.6	29.7	25.4
21	42.37	.38	40.4	32.3	26.9	23.1
22	40.44	.41	36.8	29.4	24.5	21.0
23	38.69	.45	33.6	26.9	22.4	19.2
24	37.07	.49	30.9	24.7	20.6	17.7
25	35.59	.54	28.5	22.8	19.0	16.3
26	34.22	.58	26.3	21.1	17.6	15.0
27	32.95	.62	24.4	19.5	16.3	13.9
28	31.78	.67	22.7	18.2	15.1	13.0
29	30.68	.72	21.2	16.9	14.1	12.1
30	29.66	.77	19.8	15.8	13.2	11.3
31	28.70	.82	18.5	14.8	12.3	10.6
32	27.81	.88	17.4	13.9	11.6	9.9
33	26.96	.93	16.3	13.1	10.9	9.3

18″ I BEAM—No. 180 B.

55 POUNDS PER FOOT.

Flange width	6.00	Area in square inches	16.18
Web thickness	0.46	Resistance	89.89

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*47.94*	.10	95.9	76.7	63.9	54.8
11	*43.58*	.12	79.2	63.4	52.8	45.3
12	*39.95*	.14	66.6	53.3	44.4	38.0
13	*36.88*	.16	56.7	45.4	37.8	32.4
14	*34.24*	.19	48.9	39.1	32.6	28.0
15	31.96	.21	42.6	34.1	28.4	24.4
16	29.97	.24	37.5	30.0	25.0	21.4
17	28.20	.28	33.2	26.5	22.1	19.0
18	26.64	.31	29.6	23.7	19.7	16.9
19	25.23	.34	26.6	21.2	17.7	15.2
20	23.97	.38	24.0	19.2	16.0	13.7
21	22.83	.42	21.7	17.4	14.5	12.4
22	21.79	.46	19.8	15.8	13.2	11.3
23	20.85	.50	18.1	14.5	12.1	10.4
24	19.98	.55	16.7	13.3	11.1	9.5
25	19.18	.60	15.3	12.3	10.2	8.8
26	18.44	.64	14.2	11.3	9.5	8.1
27	17.76	.69	13.2	10.5	8.8	7.5
28	17.12	.75	12.2	9.8	8.2	7.0
29	16.53	.80	11.4	9.1	7.6	6.5
30	15.98	.86	10.7	8.5	7.1	6.1
31	15.47	.92	10.0	8.0	6.7	5.7
32	14.98	.98	9.4	7.5	6.2	5.4
33	14.53	1.04	8.8	7.0	5.9	5.0

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

18″ I BEAM—No. 181 B.

60 POUNDS PER FOOT.

Flange width . . . . 6.08 | Area in square inches 17.65
Web thickness . . . . 0.54 | Resistance 94.43

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*50.36*	.10	100.7	80.6	67.1	57.6
11	*45.78*	.12	83.2	66.6	55.5	47.6
12	41.97	.14	70.0	56.0	46.6	40.0
13	38.74	.16	59.6	47.7	39.7	34.1
14	35.98	.19	51.4	41.1	34.3	29.4
15	33.58	.21	44.8	35.8	29.8	25.6
16	31.48	.24	39.4	31.5	26.2	22.5
17	29.63	.28	34.9	27.9	23.2	19.9
18	27.98	.31	31.1	24.9	20.7	17.8
19	26.51	.34	27.9	22.3	18.6	15.9
20	25.18	.38	25.2	20.1	16.8	14.4
21	23.98	.42	22.8	18.3	15.2	13.1
22	22.89	.46	20.8	16.6	13.9	11.9
23	21.90	.50	19.0	15.2	12.7	10.9
24	20.99	.55	17.5	14.0	11.7	10.0
25	20.15	.60	16.1	12.9	10.7	9.2
26	19.37	.64	14.9	11.9	9.9	8.5
27	18.65	.69	13.8	11.1	9.2	7.9
28	17.99	.75	12.8	10.3	8.6	7.3
29	17.37	.80	12.0	9.6	8.0	6.8
30	16.79	.86	11.2	9.0	7.5	6.4
31	16.25	.92	10.5	8.4	7.0	6.0
32	15.74	.98	9.8	7.9	6.6	5.6
33	15.26	1.04	9.2	7.4	6.2	5.3

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

18″ I BEAM—No. 182 B.

65 POUNDS PER FOOT.

Flange width . . . . 6.17 | Area in square inches 19.12
Web thickness. . . . . 0.63 | Resistance 98.86

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	52.73	.10	105.5	84.4	70.3	60.3
11	47.93	.12	87.1	69.7	58.1	49.8
12	43.94	.14	73.2	58.6	48.8	41.9
13	40.56	.16	62.4	49.9	41.6	35.7
14	37.66	.19	53.8	43.0	35.9	30.8
15	35.15	.21	46.9	37.5	31.2	26.8
16	32.95	.24	41.2	33.0	27.5	23.5
17	31.01	.28	36.5	29.2	24.3	20.8
18	29.29	.31	32.5	26.0	21.7	18.6
19	27.75	.34	29.2	23.4	19.5	16.7
20	26.36	.38	26.4	21.1	17.6	15.1
21	25.11	.42	23.9	19.1	15.9	13.7
22	23.97	.46	21.8	17.4	14.5	12.5
23	22.92	.50	19.9	15.9	13.3	11.4
24	21.97	.55	18.3	14.6	12.2	10.5
25	21.09	.60	16.9	13.5	11.2	9.6
26	20.28	.64	15.6	12.5	10.4	8.9
27	19.53	.69	14.5	11.6	9.6	8.3
28	18.83	.75	13.5	10.8	9.0	7.7
29	18.18	.80	12.5	10.0	8.4	7.2
30	17.58	.86	11.7	9.4	7.8	6.7
31	17.01	.92	11.0	8.8	7.3	6.3
32	16.48	.98	10.3	8.2	6.9	5.9
33	15.98	1.04	9.7	7.7	6.5	5.5

18″ I BEAM—No. 183 B.

70 POUNDS PER FOOT.

Flange width	6.50	Area in square inches	20.59
Web thickness.	0.63	Resistance	109.08

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*58.18*	.10	116.4	93.1	77.6	66.5
11	52.89	.12	96.2	76.9	64.1	55.0
12	48.48	.14	80.8	64.6	53.9	46.2
13	44.75	.16	68.8	55.1	45.9	39.3
14	41.55	.19	59.4	47.5	39.6	33.9
15	38.78	.21	51.7	41.4	34.5	29.6
16	36.36	.24	45.4	36.4	30.3	26.0
17	34.22	.28	40.3	32.2	26.8	23.0
18	32.32	.31	35.9	28.7	23.9	20.5
19	30.62	.34	32.2	25.8	21.5	18.4
20	29.09	.38	29.1	23.3	19.4	16.6
21	27.70	.42	26.4	21.1	17.6	15.1
22	26.44	.46	24.0	19.2	16.0	13.7
23	25.29	.50	22.0	17.6	14.7	12.6
24	24.24	.55	20.2	16.2	13.5	11.5
25	23.27	.60	18.6	14.9	12.4	10.6
26	22.38	.64	17.2	13.8	11.5	9.8
27	21.55	.69	16.0	12.8	10.6	9.1
28	20.78	.75	14.8	11.9	9.9	8.5
29	20.06	.80	13.8	11.1	9.2	7.9
30	19.39	.86	12.9	10.3	8.6	7.4
31	18.77	.92	12.1	9.7	8.1	6.9
32	18.18	.98	11.4	9.1	7.6	6.5
33	17.63	1.04	10.7	8.5	7.1	6.1

N. B.—For load given in Italics web must be stiffened, or load must not exceed maximum load given in column XV, page 189.

18″ I BEAM—No. 184 B.

75 POUNDS PER FOOT.

Flange width	6.58	Area in square inches	22.06
Web thickness	0.71	Resistance	113.72

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	60.65	.10	121.3	97.0	80.9	69.3
11	55.14	.12	100.3	80.2	66.8	57.3
12	50.54	.14	84.2	67.4	56.2	48.1
13	46.66	.16	71.8	57.4	47.9	41.0
14	43.32	.19	61.9	49.5	41.3	35.4
15	40.44	.21	53.9	43.1	35.9	30.8
16	37.91	.24	47.4	37.9	31.6	27.1
17	35.68	.28	42.0	33.6	28.0	24.0
18	33.70	.31	37.4	30.0	25.0	21.4
19	31.92	.34	33.6	26.9	22.4	19.2
20	30.33	.38	30.3	24.3	20.2	17.3
21	28.88	.42	27.5	22.0	18.3	15.7
22	27.57	.46	25.1	20.1	16.7	14.3
23	26.37	.50	22.9	18.3	15.3	13.1
24	25.27	.55	21.1	16.9	14.0	12.0
25	24.26	.60	19.4	15.5	12.9	11.1
26	23.33	.64	17.9	14.4	12.0	10.3
27	22.46	.69	16.6	13.3	11.1	9.5
28	21.66	.75	15.5	12.4	10.3	8.8
29	20.91	.80	14.4	11.5	9.6	8.2
30	20.22	.86	13.5	10.8	9.0	7.7
31	19.57	.92	12.6	10.1	8.4	7.2
32	18.95	.98	11.8	9.5	7.9	6.8
33	18.38	1.04	11.1	8.9	7.4	6.4

18″ I BEAM—No. 185 B.

80 POUNDS PER FOOT.

Flange width	6.66	Area in square inches. . . .	23.53
Web thickness.	0.79	Resistance.	118.15

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	63.02	.10	126.0	100.8	84.0	72.0
11	57.29	.12	104.2	83.3	69.4	59.5
12	52.51	.14	87.5	70.0	58.3	50.0
13	48.47	.16	74.6	59.7	49.7	42.6
14	45.01	.19	64.3	51.4	42.9	36.7
15	42.01	.21	56.0	44.8	37.3	32.0
16	39.38	.24	49.2	39.4	32.8	28.1
17	37.07	.28	43.6	34.9	29.1	24.9
18	35.01	.31	38.9	31.1	25.9	22.2
19	33.17	.34	34.9	27.9	23.3	20.0
20	31.51	.38	31.5	25.2	21.0	18.0
21	30.01	.42	28.6	22.9	19.1	16.3
22	28.64	.46	26.0	20.8	17.4	14.9
23	27.40	.50	23.8	19.1	15.9	13.6
24	26.26	.55	21.9	17.5	14.6	12.5
25	25.21	.60	20.2	16.1	13.4	11.5
26	24.24	.64	18.6	14.9	12.4	10.7
27	23.34	.69	17.3	13.8	11.5	9.9
28	22.51	.75	16.1	12.9	10.7	9.2
29	21.73	.80	15.0	12.0	10.0	8.6
30	21.01	.86	14.0	11.2	9.3	8.0
31	20.33	.92	13.1	10.5	8.7	7.5
32	19.69	.98	12.3	9.8	8.2	7.0
33	19.10	1.04	11.6	9.3	7.7	6.6

18″ I BEAM—No. 186 B.

85 POUNDS PER FOOT.

Flange width . . . . 7.00 | Area in square inches. . . . 25.00
Web thickness. . . . . 0.74 | Resistance. 127.74

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.* 100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	68.99	.10	138.0	110.4	92.0	78.9
11	62.72	.12	114.0	91.2	76.0	65.2
12	57.49	.14	95.8	76.7	63.9	54.8
13	53.07	.16	81.6	65.3	54.4	46.7
14	49.28	.19	70.4	56.3	46.9	40.2
15	45.99	.21	61.3	49.1	40.9	35.0
16	43.12	.24	53.9	43.1	35.9	30.8
17	40.58	.28	47.7	38.2	31.8	27.3
18	38.33	.31	42.6	34.1	28.4	24.3
19	36.31	.34	38.2	30.6	25.5	21.8
20	34.49	.38	34.5	27.6	23.0	19.7
21	32.85	.42	31.3	25.0	20.9	17.9
22	31.36	.46	28.5	22.8	19.0	16.3
23	29.99	.50	26.1	20.9	17.4	14.9
24	28.75	.55	24.0	19.2	16.0	13.7
25	27.60	.60	22.1	17.7	14.7	12.6
26	26.53	.64	20.4	16.3	13.6	11.7
27	25.55	.69	18.9	15.1	12.6	10.8
28	24.64	.75	17.6	14.1	11.7	10.1
29	23.79	.80	16.4	13.1	10.9	9.4
30	23.00	.86	15.3	12.3	10.2	8.8
31	22.25	.92	14.4	11.5	9.6	8.2
32	21.56	.98	13.5	10.8	9.0	7.7
33	20.91	1.04	12.7	10.1	8.4	7.2

18″ I BEAM—No. 187 B.

90 POUNDS PER FOOT.

Flange width. . . . . 7.08 | Area in square inches. 26.47
Web thickness . . . . 0.82 | Resistance 132.00

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	71.29	.10	142.6	114.1	95.1	81.5
11	64.81	.12	117.8	94.3	78.6	67.3
12	59.41	.14	99.0	79.2	66.0	56.6
13	54.84	.16	84.4	67.5	56.2	48.2
14	50.92	.19	72.7	58.2	48.5	41.6
15	47.53	.21	63.4	50.7	42.2	36.2
16	44.56	.24	55.7	44.6	37.1	31.8
17	41.94	.28	49.3	39.5	32.9	28.2
18	39.61	.31	44.0	35.2	29.3	25.2
19	37.52	.34	39.5	31.6	26.3	22.6
20	35.65	.38	35.7	28.5	23.8	20.4
21	33.95	.42	32.3	25.9	21.6	18.5
22	32.41	.46	29.5	23.6	19.6	16.8
23	31.00	.50	27.0	21.6	18.0	15.4
24	29.70	.55	24.8	19.8	16.5	14.1
25	28.52	.60	22.8	18.3	15.2	13.0
26	27.42	.64	21.1	16.9	14.1	12.1
27	26.40	.69	19.6	15.6	13.0	11.2
28	25.46	.75	18.2	14.5	12.1	10.4
29	24.58	.80	17.0	13.6	11.3	9.7
30	23.76	.86	15.8	12.7	10.6	9.1
31	23.00	.92	14.8	11.9	9.9	8.5
32	22.28	.98	13.9	11.1	9.3	8.0
33	21.60	1.04	13.1	10.5	8.7	7.5

15″ I BEAM—No. 150 B.

42 POUNDS PER FOOT.

Flange width	5.50	Area in square inches	12.35
Web thickness	0.41	Resistance	59.16

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*31.55*	.11	63.1	50.5	42.1	36.1
11	*28.68*	.14	52.1	41.7	34.8	29.8
12	*26.29*	.16	43.8	35.1	29.2	25.0
13	*24.27*	.19	37.3	29.9	24.9	21.3
14	22.54	.22	32.2	25.8	21.5	18.4
15	21.04	.26	28.1	22.4	18.7	16.0
16	19.72	.29	24.7	19.7	16.4	14.1
17	18.56	.33	21.8	17.5	14.6	12.5
18	17.53	.37	19.5	15.6	13.0	11.1
19	16.61	.41	17.5	14.0	11.7	10.0
20	15.78	.46	15.8	12.6	10.5	9.0
21	15.03	.50	14.3	11.5	9.5	8.2
22	14.34	.55	13.0	10.4	8.7	7.5
23	13.72	.60	11.9	9.5	8.0	6.8
24	13.15	.66	11.0	8.8	7.3	6.3
25	12.62	.71	10.1	8.1	6.7	5.8
26	12.14	.77	9.3	7.5	6.2	5.3
27	11.69	.83	8.7	6.9	5.8	4.9
28	11.27	.90	8.1	6.4	5.4	4.6
29	10.88	.96	7.5	6.0	5.0	4.3
30	10.52	1.03	7.0	5.6	4.7	4.0
31	10.18	1.10	6.6	5.3	4.4	3.8
32	9.86	1.17	6.2	4.9	4.1	3.5
33	9.56	1.24	5.8	4.6	3.9	3.3

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

15″ I BEAM—No. 151 B.

45 POUNDS PER FOOT.

Flange width	5.54	Area in square inches	13.23
Web thickness.	0.45	Resistance	61.37

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*32.73*	.11	65.5	52.4	43.6	37.4
11	29.76	.14	54.1	43.3	36.1	30.9
12	27.28	.16	45.5	36.4	30.3	26.0
13	25.18	.19	38.7	31.0	25.8	22.1
14	23.38	.22	33.4	26.7	22.3	19.1
15	21.82	.26	29.1	23.3	19.4	16.6
16	20.46	.29	25.6	20.5	17.0	14.6
17	19.25	.33	22.6	18.1	15.1	12.9
18	18.18	.37	20.2	16.2	13.5	11.5
19	17.23	.41	18.1	14.5	12.1	10.4
20	16.37	.46	16.4	13.1	10.9	9.4
21	15.59	.50	14.8	11.9	9.9	8.5
22	14.88	.55	13.5	10.8	9.0	7.7
23	14.23	.60	12.4	9.9	8.2	7.1
24	13.64	.66	11.4	9.1	7.6	6.5
25	13.09	.71	10.5	8.4	7.0	6.0
26	12.59	.77	9.7	7.7	6.5	5.5
27	12.12	.83	9.0	7.2	6.0	5.1
28	11.69	.90	8.3	6.7	5.6	4.8
29	11.29	.96	7.8	6.2	5.2	4.4
30	10.91	1.03	7.3	5.8	4.8	4.2
31	10.56	1.10	6.8	5.5	4.5	3.9
32	10.23	1.17	6.4	5.1	4.3	3.7
33	9.92	1.24	6.0	4.8	4.0	3.4

N. B.—For load given in Italics web must be stiffened, or load must not exceed maximum load given in column XV, page 189.

15″ I BEAM—No. 152 B.

50 POUNDS PER FOOT.

Flange width	5.82	Area in square inches	14.70
Web thickness.	0.48	Resistance	68.70

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	*36.64*	.11	73.3	58.6	48.9	41.9
11	33.31	.14	60.6	48.5	40.4	34.6
12	30.53	.16	50.9	40.7	33.9	29.1
13	28.18	.19	43.4	34.7	28.9	24.8
14	26.17	.22	37.4	29.9	24.9	21.4
15	24.43	.26	32.6	26.1	21.7	18.6
16	22.90	.29	28.6	22.9	19.1	16.4
17	21.55	.33	25.4	20.3	16.9	14.5
18	20.35	.37	22.6	18.1	15.1	12.9
19	19.28	.41	20.3	16.2	13.5	11.6
20	18.32	.46	18.3	14.7	12.2	10.5
21	17.45	.50	16.6	13.3	11.1	9.5
22	16.65	.55	15.1	12.1	10.1	8.7
23	15.93	.60	13.9	11.1	9.2	7.9
24	15.27	.66	12.7	10.2	8.5	7.3
25	14.66	.71	11.7	9.4	7.8	6.7
26	14.09	.77	10.8	8.7	7.2	6.2
27	13.57	.83	10.1	8.0	6.7	5.7
28	13.09	.90	9.4	7.5	6.2	5.3
29	12.63	.96	8.7	7.0	5.8	5.0
30	12.21	1.03	8.1	6.5	5.4	4.7
31	11.82	1.10	7.6	6.1	5.1	4.4
32	11.45	1.17	7.2	5.7	4.8	4.1
33	11.10	1.24	6.7	5.4	4.5	3.8

N. B.—For load given in Italics web must be stiffened, or load must not exceed maximum load given in column XV, page 189.

15″ I BEAM—No. 153 B.

55 POUNDS PER FOOT.

Flange width 5.92
Web thickness. 0.58

Area in square inches 16.18
Resistance 72.38

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	38.60	.11	77.2	61.8	51.5	44.1
11	35.09	.14	63.8	51.0	42.5	36.5
12	32.17	.16	53.6	42.9	35.7	30.6
13	29.69	.19	45.7	36.5	30.5	26.1
14	27.57	.22	39.4	31.5	26.3	22.5
15	25.74	.26	34.3	27.5	22.9	19.6
16	24.13	.29	30.2	24.1	20.1	17.2
17	22.71	.33	26.7	21.4	17.8	15.3
18	21.45	.37	23.8	19.1	15.9	13.6
19	20.32	.41	21.4	17.1	14.3	12.2
20	19.30	.46	19.3	15.4	12.9	11.0
21	18.38	.50	17.5	14.0	11.7	10.0
22	17.55	.55	16.0	12.8	10.6	9.1
23	16.78	.60	14.6	11.7	9.7	8.3
24	16.08	.66	13.4	10.7	8.9	7.7
25	15.44	.71	12.4	9.9	8.2	7.1
26	14.85	.77	11.4	9.1	7.6	6.5
27	14.30	.83	10.6	8.5	7.1	6.1
28	13.79	.90	9.9	7.9	6.6	5.6
29	13.31	.96	9.2	7.3	6.1	5.2
30	12.87	1.03	8.6	6.9	5.7	4.9
31	12.45	1.10	8.0	6.4	5.4	4.6
32	12.06	1.17	7.5	6.0	5.0	4.3
33	11.70	1.24	7.1	5.7	4.7	4.1

15″ I BEAM—No. 154 B.

60 POUNDS PER FOOT.

Flange width	6.17	Area in square inches. . . .	17.65
Web thickness.	0.55	Resistance.	82.54

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	44.02	.11	88.0	70.4	58.7	50.3
11	40.02	.14	72.7	58.2	48.5	41.6
12	36.68	.16	61.1	48.9	40.8	34.9
13	33.86	.19	52.1	41.7	34.7	29.8
14	31.44	.22	44.9	35.9	29.9	25.7
15	29.35	.26	39.1	31.3	26.1	22.4
16	27.51	.29	34.4	27.5	22.9	19.7
17	25.89	.33	30.5	24.4	20.3	17.4
18	24.46	.37	27.2	21.7	18.1	15.5
19	23.17	.41	24.4	19.5	16.3	13.9
20	22.01	.46	22.0	17.6	14.7	12.6
21	20.96	.50	20.0	16.0	13.3	11.4
22	20.01	.55	18.2	14.6	12.1	10.4
23	19.14	.60	16.6	13.3	11.1	9.5
24	18.34	.66	15.3	12.2	10.2	8.7
25	17.61	.71	14.1	11.3	9.4	8.1
26	16.93	.77	13.0	10.4	8.7	7.4
27	16.30	.83	12.1	9.7	8.0	6.9
28	15.72	.90	11.2	9.0	7.5	6.4
29	15.18	.96	10.5	8.4	7.0	6.0
30	14.67	1.03	9.8	7.8	6.5	5.6
31	14.20	1.10	9.2	7.3	6.1	5.2
32	13.76	1.17	8.6	6.9	5.7	4 9
33	13.34	1.24	8.1	6.5	5.4	4.6

15″ I BEAM—No. 155 B.

65 POUNDS PER FOOT.

Flange width	6.27	Area in square inches	19.12
Web thickness	0.65	Resistance	86.21

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	45.98	.11	92.0	73.6	61.3	52.6
11	41.80	.14	76.0	60.8	50.7	43.4
12	38.32	.16	63.9	51.1	42.6	36.5
13	35.37	.19	54.4	43.5	36.3	31.1
14	32.84	.22	46.9	37.5	31.3	26.8
15	30.65	.26	40.9	32.7	27.2	23.4
16	28.74	.29	35.9	28.7	23.9	20.5
17	27.05	.33	31.8	25.5	21.2	18.2
18	25.54	.37	28.4	22.7	18.9	16.2
19	24.20	.41	25.5	20.4	17.0	14.6
20	22.99	.46	23.0	18.4	15.3	13.1
21	21.89	.50	20.8	16.7	13.9	11.9
22	20.90	.55	19.0	15.2	12.7	10.9
23	19.99	.60	17.4	13.9	11.6	9.9
24	19.16	.66	16.0	12.8	10.6	9.1
25	18.39	.71	14.7	11.8	9.8	8.4
26	17.68	.77	13.6	10.9	9.1	7.8
27	17.03	.83	12.6	10.1	8.4	7.2
28	16.42	.90	11.7	9.4	7.8	6.7
29	15.85	.96	10.9	8.7	7.3	6.2
30	15.33	1.03	10.2	8.2	6.8	5.8
31	14.83	1.10	9.6	7.7	6.4	5.5
32	14.37	1.17	9.0	7.2	6.0	5.1
33	13.93	1.24	8.4	6.8	5.6	4.8

15″ I BEAM—No. 156 B.

70 POUNDS PER FOOT.

Flange width	6.43	Area in square inches	20.58
Web thickness	0.63	Resistance	95.83

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	51.11	.11	102.2	81.8	68.1	58.4
11	46.46	.14	84.5	67.6	56.3	48.3
12	42.59	.16	71.0	56.8	47.3	40.6
13	39.31	.19	60.5	48.4	40.3	34.6
14	36.51	.22	52.2	41.7	34.8	29.8
15	34.07	.26	45.4	36.3	30.3	26.0
16	31.94	.29	39.9	31.9	26.6	22.8
17	30.06	.33	35.4	28.3	23.6	20.2
18	28.39	.37	31.5	25.2	21.0	18.0
19	26.90	.41	28.3	22.7	18.9	16.2
20	25.55	.46	25.6	20.4	17.0	14.6
21	24.34	.50	23.2	18.5	15.5	13.2
22	23.23	.55	21.1	16.9	14.1	12.1
23	22.22	.60	19.3	15.5	12.9	11.0
24	21.30	.66	17.8	14.2	11.8	10.1
25	20.44	.71	16.4	13.1	10.9	9.3
26	19.66	.77	15.1	12.1	10.1	8.6
27	18.93	.83	14.0	11.2	9.3	8.0
28	18.25	.90	13.0	10.4	8.7	7.5
29	17.62	.96	12.2	9.7	8.1	6.9
30	17.04	1.03	11.4	9.1	7.6	6.5
31	16.49	1.10	10.6	8.5	7.1	6.1
32	15.97	1.17	10.0	8.0	6.7	5.7
33	15.49	1.24	9.4	7.5	6.3	5.4

15″ I BEAM—No. 157 B.

75 POUNDS PER FOOT.

Flange width	6.53	Area in square inches	22.06
Web thickness	0.73	Resistance	99.47

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	53.05	.11	106.1	84.9	70.7	60.6
11	48.23	.14	87.7	70.2	58.5	50.1
12	44.21	.16	73.7	58.9	49.1	42.1
13	40.81	.19	62.8	50.2	41.9	35.9
14	37.89	.22	54.1	43.3	36.1	30.9
15	35.37	.26	47.2	37.7	31.4	27.0
16	33.16	.29	41.5	33.2	27.6	23.7
17	31.20	.33	36.7	29.4	24.5	21.0
18	29.47	.37	32.7	26.2	21.8	18.7
19	27.92	.41	29.4	23.5	19.6	16.8
20	26.52	.46	26.5	21.2	17.7	15.2
21	25.26	.50	24.1	19.2	16.0	13.7
22	24.11	.55	21.9	17.5	14.6	12.5
23	23.06	.60	20.1	16.0	13.4	11.5
24	22.10	.66	18.4	14.7	12.3	10.5
25	21.22	.71	17.0	13.6	11.3	9.7
26	20.40	.77	15.7	12.6	10.5	9.0
27	19.65	.83	14.6	11.6	9.7	8.3
28	18.95	.90	13.5	10.8	9.0	7.7
29	18.29	.96	12.6	10.1	8.4	7.2
30	17.68	1.03	11.8	9.4	7.9	6.7
31	17.11	1.10	11.0	8.8	7.4	6.3
32	16.58	1.17	10.4	8.3	6.9	5.9
33	16.08	1.24	9.7	7.8	6.5	5.6

15″ I BEAM—No. 158 B.

80 POUNDS PER FOOT.

Flange width . . . . 6.63 | Area in square inches 23.53
Web thickness. . . . . 0.83 | Resistance 103.18

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
10	55.03	.11	110.1	88.1	73.4	62.9
11	50.03	.14	91.0	72.8	60.6	52.0
12	45.86	.16	76.4	61.1	51.0	43.7
13	42.33	.19	65.1	52.1	43.4	37.2
14	39.31	.22	56.2	44.9	37.4	32.1
15	36.69	.26	48.9	39.1	32.6	28.0
16	34.39	.29	43.0	34.4	28.7	24.6
17	32.37	.33	38.1	30.5	25.4	21.8
18	30.57	.37	34.0	27.2	22.6	19.4
19	28.96	.41	30.5	24.4	20.3	17.4
20	27.51	.46	27.5	22.0	18.3	15.7
21	26.20	.50	25.0	20.0	16.6	14.3
22	25.01	.55	22.7	18.2	15.2	13.0
23	23.93	.60	20.8	16.6	13.9	11.9
24	22.93	.66	19.1	15.3	12.7	10.9
25	22.01	.71	17.6	14.1	11.7	10.1
26	21.17	.77	16.3	13.0	10.9	9.3
27	20.38	.83	15.1	12.1	10.1	8.6
28	19.65	.90	14.0	11.2	9.4	8.0
29	18.98	.96	13.1	10.5	8.7	7.5
30	18.34	1.03	12.2	9.8	8.2	7.0
31	17.75	1.10	11.5	9.2	7.6	6.5
32	17.20	1.17	10.8	8.6	7.2	6.1
33	16.68	1.24	10.1	8.1	6.7	5.8

12″ I BEAM—No. 120 B.

31.5 POUNDS PER FOOT.

Flange width . . . . 5.00 | Area in square inches. 9.26
Web thickness . . . . 0.35 | Resistance. 36.45

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributing Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	*24.30*	.09	60.8	48.6	40.5	34.7
9	*21.60*	.12	48.0	38.4	32.0	27.4
10	*19.44*	.14	38.9	31.1	25.9	22.2
11	17.67	.17	32.1	25.7	21.4	18.4
12	16.20	.21	27.0	21.6	18.0	15.4
13	14.95	.24	23.0	18.4	15.3	13.1
14	13.89	.28	19.8	15.9	13.2	11.3
15	12.96	.32	17.3	13.8	11.5	9.9
16	12.15	.37	15.2	12.2	10.1	8.7
17	11.44	.41	13.5	10.8	9.0	7.7
18	10.80	.46	12.0	9.6	8.0	6.9
19	10.23	.52	10.8	8.6	7.2	6.2
20	9.72	.57	9.7	7.8	6.5	5.6
21	9.26	.63	8.8	7.1	5.9	5.0
22	8.84	.69	8.0	6.4	5.4	4.6
23	8.45	.76	7.3	5.9	4.9	4.2
24	8.10	.82	6.8	5.4	4.5	3.9
25	7.78	.89	6.2	5.0	4.1	3.6
26	7.48	.97	5.8	4.6	3.8	3.3
27	7.20	1.04	5.3	4.3	3.6	3.0
28	6.94	1.12	5.0	4.0	3.3	2.8
29	6.70	1.20	4 6	3.7	3 1	2.6
30	6.48	1.29	4.3	3.5	2.9	2.5
31	6.27	1.37	4.0	3.2	2.7	2.3

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, pages 188 to 191.

12″ I BEAM—No. 121 B.

35 POUNDS PER FOOT.

Flange width	5.08	Area in square inches	10.29
Web thickness	0.43	Resistance	38.49

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	25.66	.09	64.2	51.3	42.8	36.7
9	22.81	.12	50.7	40.6	33.8	29.0
10	20.53	.14	41.1	32.8	27.4	23.5
11	18.66	.17	33.9	27.1	22.6	19.4
12	17.11	.21	28.5	22.8	19.0	16.3
13	15.79	.24	24.3	19.4	16.2	13.9
14	14.66	.28	20.9	16.8	14.0	12.0
15	13.69	.32	18.3	14.6	12.2	10.4
16	12.83	.37	16.0	12.8	10.7	9.2
17	12.08	.41	14.2	11.4	9.5	8.1
18	11.41	.46	12.7	10.1	8.5	7.2
19	10.80	.52	11.4	9.1	7.6	6.5
20	10.26	.57	10.3	8.2	6.8	5.9
21	9.78	.63	9.3	7.5	6.2	5.3
22	9.33	.69	8.5	6.8	5.7	4.8
23	8.93	.76	7.8	6.2	5.2	4.4
24	8.55	.82	7.1	5.7	4.8	4.1
25	8.21	.89	6.6	5.3	4.4	3.8
26	7.90	.97	6.1	4.9	4.1	3.5
27	7.60	1.04	5.6	4.5	3.8	3.2
28	7.33	1.12	5.2	4.2	3.5	3.0
29	7.08	1.20	4.9	3.9	3.3	2.8
30	6.84	1.29	4.6	3.6	3.0	2.6
31	6.62	1.37	4.3	3.4	2.8	2.4

12″ I BEAM—No. 122 B.

40 POUNDS PER FOOT.

Flange width	5.25	Area in square inches	11.76
Web thickness	0.42	Resistance	45.78

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	*30.53*	.09	76.3	61.1	50.9	43.6
9	*27.13*	.12	60.3	48.2	40.2	34.5
10	24.42	.14	48.8	39.1	32.6	27.9
11	22.20	.17	40.4	32.3	26.9	23.1
12	20.35	.21	33.9	27.1	22.6	19.4
13	18.78	.24	28.9	23.1	19.3	16.5
14	17.44	.28	24.9	19.9	16.6	14.2
15	16.28	.32	21.7	17.4	14.5	12.4
16	15.26	.37	19.1	15.3	12.7	10.9
17	14.36	.41	16.9	13.5	11.3	9.7
18	13.56	.46	15.1	12.1	10.0	8.6
19	12.85	.52	13.5	10.8	9.0	7.7
20	12.21	.57	12.2	9.8	8.1	7.0
21	11.63	.63	11.1	8.9	7.4	6.3
22	11.10	.69	10.1	8.1	6.7	5.8
23	10.62	.76	9.2	7.4	6.2	5.3
24	10.17	.82	8.5	6.8	5.7	4.8
25	9.77	.89	7.8	6.3	5.2	4.5
26	9.39	.97	7.2	5.8	4.8	4.1
27	9.04	1.04	6.7	5.4	4 5	3.8
28	8.72	1.12	6.2	5.0	4.2	3.6
29	8.42	1.20	5.8	4.6	3 9	3.3
30	8.14	1.29	5.4	4.3	3.6	3.1
31	7.88	1.37	5.1	4.1	3.4	2.9

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in columns XV, page 189.

12″ I BEAM—No. 123 B.

45 POUNDS PER FOOT.

Flange width	5.37	Area in square inches	13.23
Web thickness	0.54	Resistance	48.71

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	32.47	.09	81.2	64.9	54.1	46.4
9	28.86	.12	64.1	51.3	42.8	36.7
10	25.98	.14	52.0	41.6	34.6	29.7
11	23.62	.17	42.9	34.4	28.6	24.5
12	21.65	.21	36.1	28.9	24.1	20.6
13	19.98	.24	30.7	24.6	20.5	17.6
14	18.56	.28	26.5	21.2	17.7	15.2
15	17.32	.32	23.1	18.5	15.4	13.2
16	16.24	.37	20.3	16.2	13.5	11.6
17	15.28	.41	18.0	14.4	12.0	10.3
18	14.43	.46	16.0	12.8	10.7	9.2
19	13.67	.52	14.4	11.5	9.6	8.2
20	12.99	.57	13.0	10.4	8.7	7.4
21	12.37	.63	11.8	9.4	7.9	6.7
22	11.81	.69	10.7	8.6	7.2	6.1
23	11.29	.76	9.8	7.9	6.5	5.6
24	10.82	.82	9.0	7.2	6.0	5.2
25	10.39	.89	8.3	6.7	5 5	4.8
26	9.99	.97	7.7	6.1	5.1	4.4
27	9.62	1.04	7.1	5.7	4.8	4.1
28	9.28	1.12	6.6	5.3	4.4	3.8
29	8.96	1.20	6 2	4.9	4 1	3.5
30	8 66	1.29	5.8	4.6	3.8	3.3
31	8.38	1.37	5 4	4.3	3.6	3.1

12″ I BEAM—No. 124 B.

50 POUNDS PER FOOT.

Flange width	5.68	Area in square inches	14.70
Web thickness	0.55	Resistance	55.35

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	36.90	.09	92.3	73.8	61.5	52.7
9	32.80	.12	72.9	58.3	48.6	41.7
10	29.52	.14	59.0	47.2	39.4	33.7
11	26.83	.17	48.8	39.0	32.5	27.9
12	24.60	.21	41.0	32.8	27.3	23.4
13	22.71	.24	34.9	28.0	23.3	20.0
14	21.08	.28	30.1	24.1	20.1	17.2
15	19.68	.32	26.2	21.0	17.5	15.0
16	18.45	.37	23.1	18.5	15.4	13.2
17	17.36	.41	20.4	16.3	13.6	11.7
18	16.40	.46	18.2	14.6	12.1	10.4
19	15.54	.52	16.4	13.1	10.9	9.3
20	14.76	.57	14.8	11.8	9.8	8.4
21	14.06	.63	13.4	10.7	8.9	7.7
22	13.42	.69	12.2	9.8	8.1	7.0
23	12.83	.76	11.2	8.9	7.4	6.4
24	12.30	.82	10.3	8.2	6.8	5.9
25	11.81	.89	9.4	7.6	6.3	5.4
26	11.35	.97	8.7	7.0	5.8	5.0
27	10.93	1.04	8.1	6.5	5.4	4.6
28	10.54	1.12	7.5	6.0	5.0	4.3
29	10.18	1.20	7.0	5.6	4.7	4.0
30	9.84	1.29	6.6	5.2	4.4	3.7
31	9.52	1.37	6.1	4.9	4.1	3.5

12″ I BEAM—No. 125 B.

55 POUNDS PER FOOT.

Flange width	5.75	Area in square inches	16.18
Web thickness	0.56	Resistance	61.34

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	40.90	.09	102.3	81.8	68.2	58.4
9	36.35	.12	80.8	64.6	53.8	46.2
10	32.72	.14	65.4	52.4	43.6	37.4
11	29.74	.17	54.1	43.3	36.0	30.9
12	27.26	.21	45.4	36.4	30.3	26.0
13	25.17	.24	38.7	31.0	25.8	22.1
14	23.37	.28	33.4	26.7	22.3	19.1
15	21.81	.32	29.1	23.3	19.4	16.6
16	20.45	.37	25.6	20.5	17.0	14.6
17	19.24	.41	22.6	18.1	15.1	12.9
18	18.17	.46	20.2	16.2	13.5	11.5
19	17.22	.52	18.1	14.5	12.1	10.4
20	16.36	.57	16.4	13.1	10.9	9.4
21	15.58	.63	14.8	11.9	9.9	8.5
22	14.87	.69	13.5	10.8	9.0	7.7
23	14.22	.76	12.4	9.9	8.2	7.1
24	13.63	.82	11.4	9.1	7.6	6.5
25	13.09	.89	10.5	8.4	7.0	6.0
26	12.58	.97	9.7	7.7	6.5	5.5
27	12.12	1.04	9.0	7.2	6.0	5.1
28	11.68	1.12	8.3	6.7	5.6	4.8
29	11.28	1.20	7 8	6.2	5.2	4.4
30	10.91	1.29	7.3	5 8	4.8	4.2
31	10.55	1.37	6.8	5.4	4.5	3.9

12″ I BEAM—No. 126 B.

60 POUNDS PER FOOT.

Flange width. . . . . 5.87 | Area in square inches 17.65
Web thickness . . . . 0.68 | Resistance 64.30

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	42.86	.09	107.2	85.7	71.4	61.2
9	38.10	.12	84.7	67.7	56.4	48.4
10	34.29	.14	68.6	54.9	45.7	39.2
11	31.17	.17	56.7	45.3	37.8	32.4
12	28.58	.21	47.6	38.1	31.8	27.2
13	26.38	.24	40.6	32.5	27.1	23.2
14	24.49	.28	35.0	28.0	23.3	20.0
15	22.86	.32	30.5	24.4	20.3	17.4
16	21.43	.37	26.8	21.4	17.9	15.3
17	20.17	.41	23.7	19.0	15.8	13.6
18	19.05	.46	21.2	16.9	14.1	12.1
19	18.05	.52	19.0	15.2	12.7	10.9
20	17.15	.57	17.2	13.7	11.4	9.8
21	16.33	.63	15.6	12.4	10.4	8.9
22	15.59	.69	14.2	11.3	9.4	8.1
23	14.91	.76	13.0	10.4	8.6	7.4
24	14.29	.82	11.9	9.5	7.9	6.8
25	13.72	.89	11.0	8.8	7.3	6.3
26	13.19	.97	10.1	8.1	6.8	5.8
27	12.70	1.04	9.4	7.5	6.3	5.4
28	12.25	1.12	8.7	7.0	5.8	5.0
29	11.82	1.20	8.2	6.5	5 4	4.7
30	11.43	1.29	7.6	6.1	5.1	4.4
31	11.06	1.37	7.1	5.7	4.8	4.1

12″ I BEAM—No. 127 B.

65 POUNDS PER FOOT.

Flange width . . . . 5.99 | Area in square inches 19.12
Web thickness . . . . 0.80 | Resistance 67.25

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	Greatest Safe Load in Net Tons.	Deflection in Inches.	Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below. 100 Pounds per Square Foot.	125 Pounds per Square Foot.	150 Pounds per Square Foot.	175 Pounds per Square Foot.
8	44.83	.09	112.1	89.7	74.7	64.1
9	39.85	.12	88.6	70.8	59.0	50.6
10	35.87	.14	71.7	57.4	47.8	41.0
11	32.61	.17	59.3	47.4	39.5	33.9
12	29.89	.21	49.8	39.9	33.2	28.5
13	27.59	.24	42.4	34.0	28.3	24.3
14	25.62	.28	36.6	29.3	24.4	20.9
15	23.91	.32	31.9	25.5	21.3	18.2
16	22.42	.37	28.0	22.4	18.7	16.0
17	21.10	.41	24.8	19.9	16.5	14.2
18	19.93	.46	22.1	17.7	14.8	12.7
19	18.88	.52	19.9	15.9	13.2	11.4
20	17.93	.57	17.9	14.3	12.0	10.2
21	17.08	.63	16.3	13.0	10.8	9.3
22	16.30	.69	14.8	11.9	9.9	8.5
23	15.59	.76	13.6	10.8	9.0	7.7
24	14.94	.82	12.5	10.0	8.3	7.1
25	14.35	.89	11.5	9.2	7.7	6.6
26	13.79	.97	10.6	8.5	7.1	6.1
27	13.28	1.04	9.8	7.9	6.6	5.6
28	12.81	1.12	9.2	7.3	6.1	5.2
29	12.37	1 20	8 5	6.8	5 7	4.9
30	11 96	1 29	8 0	6.4	5.3	4.6
31	11.57	1.37	7 5	6.0	5.0	4.3

10″ I BEAM—No. 100 B.

25 POUNDS PER FOOT.

Flange width . . . . 4.66 | Area in square inches 7.35
Web thickness. . . . . 0.31 | Resistance 24.61

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	*16.41*	.11	41.0	32.8	27.4	23.4
9	*14.60*	.14	32.4	25.9	21.6	18.5
10	13.13	.17	26.3	21.0	17.5	15.0
11	11.93	.21	21.7	17.4	14.5	12.4
12	10.94	.25	18.2	14.6	12.2	10.4
13	10.10	.29	15.5	12.4	10.4	8.9
14	9.38	.34	13.4	10.7	8.9	7.7
15	8.75	.39	11.7	9.3	7.8	6.7
16	8.20	.44	10.3	8.2	6.8	5.9
17	7.72	.50	9.1	7.3	6.1	5.2
18	7.29	.56	8.1	6.5	5.4	4.6
19	6.91	.62	7.3	5.8	4.8	4.2
20	6.56	.69	6.6	5.2	4.4	3.7
21	6.25	.76	6.0	4.8	4.0	3.4
22	5.97	.83	5.4	4.3	3.6	3.1
23	5 71	.91	5.0	4.0	3.3	2.8
24	5.47	.99	4.6	3.6	3.0	2.6
25	5.25	1.07	4.2	3.4	2.8	2.4
26	5.05	1.16	3.9	3.1	2.6	2.2
27	4.86	1.25	3.6	2.9	2.4	2.1
28	4.69	1.34	3.4	2.7	2.2	1.9
29	4.53	1.44	3.1	2.5	2.1	1.8
30	4.38	1.54	2.9	2.3	1.9	1.7
31	4.23	1.65	2.7	2.2	1.8	1.6

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, page 191.

10″ I BEAM—No. 101 B.

30 POUNDS PER FOOT.

Flange width	4.80	Area in square inches	8.82
Web thickness.	0.45	Resistance	27.08

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	18.06	.11	45.2	36.1	30.1	25.8
9	16.05	.14	35.7	28.5	23.8	20.4
10	14.44	.17	28.9	23.1	19.3	16.5
11	13.13	.21	23.9	19.1	15.9	13.6
12	12.04	.25	20.1	16.1	13.4	11.5
13	11.11	.29	17.1	13.7	11.4	9.8
14	10.32	.34	14.7	11.8	9.8	8.4
15	9.63	.39	12.8	10.3	8.6	7.3
16	9.03	.44	11.3	9.0	7.5	6.5
17	8.50	.50	10.0	8.0	6.7	5.7
18	8.02	.56	8.9	7.1	5.9	5.1
19	7.60	.62	8.0	6.4	5.3	4.6
20	7.22	.69	7.2	5.8	4.8	4.1
21	6.88	.76	6.6	5.2	4.4	3.7
22	6.57	.83	6.0	4.8	4.0	3.4
23	6.28	.91	5 5	4.4	3.6	3.1
24	6.02	.99	5.0	4.0	3.3	2.9
25	5.78	1.07	4.6	3.7	3.1	2.6
26	5.56	1.16	4 3	3.4	2.9	2.4
27	5.35	1.25	4.0	3.2	2.6	2.3
28	5.14	1.34	3.7	2.9	2.4	2.1
29	4.98	1.44	3.4	2.7	2.3	2.0
30	4.81	1 54	3.2	2.6	2.1	1.8
31	4.66	1.65	3.0	2.4	2.0	1.7

10″ I BEAM—No. 102 B.

35 POUNDS PER FOOT.

Flange width	5.00	Area in square inches	10.29
Web thickness.	0.44	Resistance	32.63

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	21.75	.11	54.4	43.5	36.2	31.1
9	19.34	.14	43.0	34.4	28.7	24.6
10	17.40	.17	34.8	27.8	23.2	19.9
11	15.82	.21	28.8	23.0	19.2	16.4
12	14.50	.25	24.2	19.3	16.1	13.8
13	13.39	.29	20.6	16.5	13.7	11.8
14	12.43	.34	17.8	14.2	11.8	10.1
15	11.60	.39	15.5	12.4	10.3	8.8
16	10.88	.44	13.6	10.9	9.1	7.8
17	10.24	.50	12.0	9.6	8.0	6.9
18	9.67	.56	10.7	8.6	7.2	6.1
19	9.16	.62	9.6	7.7	6.4	5.5
20	8.70	.69	8.7	7.0	5.8	5.0
21	8.29	.76	7.9	6.3	5.3	4.5
22	7.91	.83	7.2	5.8	4.8	4.1
23	7.57	.91	6 6	5.3	4.4	3.8
24	7.25	.99	6.0	4.8	4.0	3.5
25	6.96	1.07	5.6	4.5	3.7	3.2
26	6.69	1.16	5 1	4.1	3.4	2.9
27	6.45	1.25	4.8	3.8	3.2	2.7
28	6.22	1.34	4.4	3.6	3.0	2.5
29	6.00	1.44	4.1	3.3	2.8	2.4
30	5.80	1.54	3.9	3.1	2.6	2.2
31	5.61	1.65	3.6	2.9	2.4	2.1

10″ I BEAM—No. 103 B.

40 POUNDS PER FOOT.

Flange width . . . . 5.15 | Area in square inches 11.76
Web thickness . . . . 0.59 | Resistance 35.10

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.* 100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
8	23.40	.11	58.5	46.8	39.0	33.4
9	20.80	.14	46.2	37.0	30.8	26.4
10	18.72	.17	37.4	30.0	25.0	21.4
11	17.02	.21	30.9	24.8	20.6	17.7
12	15.60	.25	26.0	20.8	17.3	14.9
13	14.40	.29	22.2	17.7	14.8	12.7
14	13.37	.34	19.1	15.3	12.7	10.9
15	12.48	.39	16.6	13.3	11.1	9.5
16	11.70	.44	14.6	11.7	9.7	8.4
17	11.01	.50	13.0	10.4	8.6	7.4
18	10.40	.56	11.6	9.2	7.7	6.6
19	9.85	.62	10.4	8.3	6.9	5.9
20	9.36	.69	9.4	7.5	6.2	5.3
21	8.91	.76	8.5	6.8	5.7	4.8
22	8.51	.83	7.7	6.2	5.2	4.4
23	8.14	.91	7.1	5.7	4.7	4.0
24	7.80	.99	6.5	5.2	4.3	3.7
25	7.49	1.07	6.0	4.8	4.0	3.4
26	7.20	1.16	5.5	4.4	3.7	3.2
27	6.93	1.25	5.1	4.1	3.4	2.9
28	6.69	1.34	4.8	3.8	3.2	2.7
29	6.45	1.44	4.4	3.6	3.0	2.5
30	6.24	1.54	4.2	3.3	2.8	2.4
31	6.04	1.65	3.9	3.1	2.6	2.2

9″ I BEAM—No. 90 B.

21 POUNDS PER FOOT.

Flange width	4.33	Area in square inches	6.18
Web thickness	0.29	Resistance	18.88

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	*16.78*	.07	55.9	44.7	37.3	32.0
7	*14.37*	.09	41.1	32.8	27.4	23.5
8	*12.59*	.12	31.5	25.2	21.0	18.0
9	*11.19*	.15	24.9	19.9	16.6	14.2
10	10.07	.19	20.1	16.1	13.4	11.5
11	9.15	.23	16.6	13.3	11.1	9.5
12	8.39	.27	14.0	11.2	9.3	8.0
13	7.74	.32	11.9	9.5	7.9	6.8
14	7.19	.37	10.3	8.2	6.9	5.9
15	6.71	.43	8.9	7.2	6.0	5.1
16	6.29	.49	7.9	6.3	5.2	4.5
17	5.92	.55	7.0	5.6	4.6	4.0
18	5.59	.62	6 2	5.0	4.1	3 6
19	5.30	.69	5.6	4.5	3.7	3.2
20	5.03	.76	5.0	4.0	3.4	2.9
21	4.79	.84	4.6	3.6	3.0	2.6
22	4.58	.92	4.2	3.3	2.8	2.4
23	4.38	1.01	3.8	3.0	2.5	2.2
24	4.19	1.10	3.5	2.8	2.3	2.0
25	4.03	1 19	3.2	2.6	2.1	1.8
26	3.87	1.29	3.0	2.4	2.0	1.7
27	3.73	1.39	2.8	2.2	1.8	1.6
28	3.60	1 49	2.6	2.1	1.7	1.5
29	3.47	1.60	2.4	1.9	1.6	1.4

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, page 191.

9″ I BEAM—No. 91 B.

25 POUNDS PER FOOT.

Flange width . . . . 4.43 | Area in square inches 7.35
Web thickness . . . . 0.39 | Resistance 20.63

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.* 100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	18.34	.07	61.1	48.9	40.8	34.9
7	15.72	.09	44.9	35.9	29.9	25.7
8	13.75	.12	34.4	27.5	22.9	19.7
9	12.22	.15	27.2	21.7	18.1	15.5
10	11.00	.19	22.0	17.6	14.7	12.6
11	10.00	.23	18.2	14.5	12.1	10.4
12	9.17	.27	15.3	12.2	10.2	8.7
13	8.46	.32	13.0	10.4	8.7	7.4
14	7.86	.37	11.2	9.0	7.5	6.4
15	7.33	.43	9.8	7.8	6.5	5.6
16	6.88	.49	8.6	6.9	5.7	4.9
17	6.47	.55	7.6	6.1	5.1	4.4
18	6.11	.62	6.8	5.4	4.5	3.9
19	5.79	.69	6.1	4.9	4.1	3.5
20	5.50	.76	5.5	4.4	3.7	3.1
21	5.24	.84	5.0	4.0	3.3	2.9
22	5.00	.92	4.5	3.6	3.0	2.6
23	4.78	1.01	4.2	3.3	2.8	2.4
24	4.58	1.10	3.8	3.1	2.5	2.2
25	4.40	1.19	3.5	2.8	2.3	2.0
26	4.23	1.29	3.3	2.6	2.2	1.9
27	4.08	1.39	3.0	2.4	2.0	1.7
28	3.93	1.49	2.8	2.2	1.9	1.6
29	3.79	1.60	2.6	2.1	1.7	1.5

9″ I BEAM—No. 92 B.

30 POUNDS PER FOOT.

Flange width . . . . 4.60 | Area in square inches 8.82
Web thickness . . . . 0.56 | Resistance 22.84

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	20.31	.07	67.7	54.2	45.1	38.7
7	17.41	.09	49.7	39.8	33.2	28.4
8	15.23	.12	38.1	30.5	25.4	21.8
9	13.54	.15	30.1	24.1	20.1	17.2
10	12.18	.19	24.4	19.5	16.2	13.9
11	11.08	.23	20.1	16.1	13.4	11.5
12	10.15	.27	16.9	13.5	11.3	9.7
13	9.37	.32	14.4	11.5	9.6	8.2
14	8.70	.37	12.4	9.9	8.3	7.1
15	8.12	.43	10.8	8.7	7.2	6.2
16	7.62	.49	9.5	7.6	6.4	5.4
17	7.17	.55	8.4	6.7	5.6	4.8
18	6.77	.62	7.5	6.0	5.0	4.3
19	6.41	.69	6.7	5.4	4.5	3.9
20	6.09	.76	6.1	4.9	4.1	3.5
21	5.80	.84	5.5	4.4	3.7	3.2
22	5.54	.92	5.0	4.0	3.4	2.9
23	5.30	1.01	4.6	3.7	3.1	2.6
24	5.08	1.10	4.2	3.4	2.8	2.4
25	4.87	1.19	3.9	3.1	2.6	2.2
26	4.69	1.29	3.6	2.9	2.4	2.1
27	4.51	1.39	3.3	2.7	2.2	1.9
28	4.35	1.49	3.1	2.5	2.1	1.8
29	4.20	1.60	2.9	2.3	1.9	1.7

9″ I BEAM—No. 93 B.

35 POUNDS PER FOOT.

Flange width	4.76	Area in square inches	10.29
Web thickness	0.72	Resistance	25.06

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	22.27	.07	74.2	59.4	49.5	42.4
7	19.09	.09	54.5	43.6	36.4	31.2
8	16.71	.12	41.8	33.4	27.9	23.9
9	14.85	.15	33.0	26.4	22.0	18.9
10	13.36	.19	26.7	21.4	17.8	15.3
11	12.15	.23	22.1	17.7	14.7	12.6
12	11.14	.27	18.6	14.9	12.4	10.6
13	10.28	.32	15.8	12.7	10.5	9.0
14	9.55	.37	13.6	10.9	9.1	7.8
15	8.91	.43	11.9	9.5	7.9	6.8
16	8.35	.49	10.4	8.4	7.0	6.0
17	7.86	.55	9.2	7.4	6.2	5.3
18	7.42	.62	8.2	6.6	5.5	4.7
19	7.03	.69	7.4	5.9	4.9	4.2
20	6.68	.76	6.7	5.3	4.5	3.8
21	6.36	.84	6.1	4.8	4.0	3.5
22	6.07	.92	5.5	4.4	3.7	3.2
23	5.81	1.01	5.1	4.0	3.4	2.9
24	5.57	1.10	4.6	3.7	3.1	2.7
25	5.35	1.19	4.3	3.4	2.9	2.4
26	5.14	1.29	4.0	3.2	2.6	2.3
27	4.95	1.39	3.7	2 9	2.4	2.1
28	4.77	1.49	3.4	2.7	2.3	1.9
29	4.61	1.60	3.2	2.5	2.1	1.8

8″ I BEAM—No. 80 B.

18 POUNDS PER FOOT.

Flange width	4.00	Area in square inches	5.29
Web thickness	0.27	Resistance	14.34

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	*12.75*	.08	42.5	34.0	28.3	24.3
7	*10.93*	.10	31.2	25.0	20.8	17.8
8	9.56	.14	23.9	19.1	15.9	13.7
9	8.50	.17	18.9	15.1	12.6	10.8
10	7.65	.21	15.3	12.2	10.2	8.7
11	6.95	.26	12.6	10.1	8.4	7.2
12	6.38	.31	10.6	8.5	7.1	6.1
13	5.88	.36	9.0	7.2	6.0	5.2
14	5.46	.42	7.8	6.2	5.2	4.4
15	5.10	.48	6.8	5.4	4.5	3.9
16	4.78	.55	6.0	4.8	4.0	3.4
17	4.50	.62	5.3	4.2	3.5	3 0
18	4.25	.69	4.7	3.8	3.1	2.7
19	4.03	.77	4.2	3.4	2.8	2.4
20	3.82	.86	3.8	3.1	2.5	2.2
21	3.64	.94	3.5	2.8	2.3	2.0
22	3.48	1.04	3.2	2.5	2 1	1.8
23	3.33	1.13	2.9	2.3	1.9	1.7
24	3.19	1.23	2.7	2.1	1.8	1.5
25	3.06	1.34	2.4	2.0	1.6	1.4
26	2.94	1.45	2.3	1.8	1.5	1.3
27	2.83	1.56	2.1	1.7	1.4	1.2
28	2.73	1.68	2.0	1.6	1.3	1.1
29	2.64	1.80	1.8	1.5	1.2	1.0

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, page 191.

8″ I BEAM—No. 81 B.

20.5 POUNDS PER FOOT.

Flange width . . . . 4.08 | Area in square inches 6.03
Web thickness. . . . . 0.35 | Resistance 15.32

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	Greatest Safe Load in Net Tons.	Deflection in Inches.	Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.			
			100 Pounds per Square Foot.	125 Pounds per Square Foot.	150 Pounds per Square Foot.	175 Pounds per Square Foot.
6	13.62	.08	45.4	36.3	30.3	26.0
7	11.67	.10	33.3	26.7	22.2	19.1
8	10.22	.14	25.6	20.4	17.0	14.6
9	9.08	.17	20.2	16.1	13.5	11.5
10	8.17	.21	16.3	13.1	10.9	9.3
11	7.43	.26	13.5	11.8	9.0	7.7
12	6.81	.31	11.4	9.1	7.6	6.5
13	6.29	.36	9.7	7.7	6.5	5.5
14	5.84	.42	8.3	6.7	5.6	4.8
15	5.45	.48	7.3	5.8	4.8	4.2
16	5.11	.55	6.4	5.1	4.3	3.7
17	4.81	.62	5.7	4.5	3.8	3.2
18	4.54	.69	5.0	4.0	3.4	2.9
19	4.30	.77	4.5	3.6	3.0	2.6
20	4.09	.86	4.1	3.3	2.7	2.3
21	3.89	.94	3.7	3.0	2.5	2.1
22	3.71	1.04	3.4	2.7	2.2	1.9
23	3.55	1.13	3.1	2.5	2.1	1.8
24	3.41	1.23	2.8	2.3	1.9	1.6
25	3.27	1.34	2.6	2.1	1.7	1.5
26	3.14	1.45	2.4	1.9	1.6	1.4
27	3.03	1.56	2.2	1.8	1.5	1.3
28	2.92	1.68	2.1	1.7	1.4	1.2
29	2.82	1.80	1.9	1.6	1.3	1.1

8″ I BEAM—No. 82 B.

23 POUNDS PER FOOT.

Flange width	4.17	Area in square inches	6.76
Web thickness	0.44	Resistance	16.30

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	14.49	.08	48.3	38.6	32.2	27.6
7	12.42	.10	35.5	28.4	23.7	20.3
8	10.87	.14	27.2	21.7	18.1	15.5
9	9.66	.17	21.5	17.2	14.3	12.3
10	8.70	.21	17.4	13.9	11.6	9.9
11	7.90	.26	14.4	11.5	9.6	8.2
12	7.25	.31	12.1	9.7	8.1	6.9
13	6.69	.36	10.3	8.2	6.9	5.9
14	6.21	.42	8.9	7.1	5.9	5.1
15	5.80	.48	7.7	6.2	5.2	4.4
16	5.43	.55	6.8	5.4	4.5	3.9
17	5.11	.62	6.0	4.8	4.0	3.4
18	4.83	.69	5.4	4.3	3.6	3.1
19	4.58	.77	4 8	3.9	3.2	2 8
20	4.35	.86	4.4	3.5	2.9	2.5
21	4.14	.94	3.9	3.2	2.6	2.3
22	3.95	1.04	3.6	2.9	2.4	2.1
23	3.78	1.13	3.3	2.6	2.2	1.9
24	3.62	1.23	3.0	2.4	2.0	1.7
25	3.48	1.34	2.8	2.2	1.9	1.6
26	3.34	1.45	2.6	2.1	1.7	1.5
27	3.22	1.56	2.4	1 9	1.6	1.4
28	3.11	1.68	2.2	1.8	1.5	1.3
29	3.00	1.80	2.1	1.7	1.4	1.2

8″ I BEAM—No. 83 B.

25.5 POUNDS PER FOOT.

Flange width	4.26	Area in square inches	7.50
Web thickness	0.53	Resistance	17.29

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	15.37	.08	51.2	41.0	34.1	29.3
7	13.17	.10	37.6	30.1	25.1	21.5
8	11.52	.14	28.8	23.0	19.2	16.5
9	10.24	.17	22.8	18.2	15.2	13.0
10	9.22	.21	18.4	14.8	12.3	10.5
11	8.38	.26	15.2	12.2	10.2	8.7
12	7.68	.31	12.8	10.2	8.5	7.3
13	7.09	.36	10.9	8.7	7.3	6.2
14	6.58	.42	9.4	7.5	6.3	5.4
15	6.15	.48	8.2	6.6	5.5	4.7
16	5.76	.55	7 2	5.8	4.8	4.1
17	5.42	.62	6.4	5.1	4.3	3.6
18	5.12	.69	5.7	4.6	3.8	3.3
19	4.85	.77	5.1	4.1	3.4	2.9
20	4.61	.86	4.6	3.7	3.1	2.6
21	4.39	.94	4.2	3.3	2.8	2.4
22	4.19	1.04	3.8	3.0	2.5	2.2
23	4.01	1.13	3.5	2.8	2.3	2.0
24	3.84	1.23	3.2	2.6	2.1	1.8
25	3.69	1.34	3.0	2.4	2.0	1.7
26	3.55	1.45	2.7	2.2	1.8	1.6
27	3.41	1.56	2.5	2.0	1.7	1.4
28	3.29	1.68	2.4	1.9	1.6	1.3
29	3.18	1.80	2.2	1.8	1.5	1.3

7″ I BEAM—No. 70 B.

15 POUNDS PER FOOT.

Flange width	3.66	Area in square inches	4.41
Web thickness	0.25	Resistance	10.46

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Loads as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	*9.30*	.09	31.0	24.8	20.7	17.7
7	7.97	.12	22.8	18.2	15.2	13.0
8	6.97	.16	17.4	13.9	11.6	10.0
9	6.20	.20	13.8	11.0	9.2	7.9
10	5.58	.24	11.2	8.9	7.4	6.4
11	5.07	.30	9.2	7.4	6.1	5.3
12	4.65	.35	7.8	6.2	5.2	4.4
13	4.29	.41	6.6	5.3	4.4	3.8
14	3.99	.48	5.7	4.6	3.8	3.3
15	3.72	.55	5.0	4.0	3.3	2.8
16	3.49	.63	4.4	3.5	2.9	2.5
17	3.28	.71	3.9	3.1	2.6	2.2
18	3.10	.79	3.4	2.8	2.3	2.0
19	2.94	.88	3.1	2.5	2.1	1.8
20	2.79	.98	2.8	2.2	1.9	1.6
21	2.66	1.08	2.5	2.0	1.7	1.4
22	2.54	1.19	2.3	1.8	1.5	1.3
23	2.43	1.30	2.1	1.7	1.4	1.2
24	2.32	1.41	1.9	1.5	1.3	1.1
25	2.23	1.53	1.8	1.4	1.2	1.0
26	2.15	1.66	1.7	1.3	1.1	.9
27	2.07	1.79	1.5	1.2	1.0	.9
28	1.99	1.92	1.4	1.1	.9	.8
29	1.92	2.06	1.3	1.1	.9	.8

N. B.—For load given in Italics web must be stiffened, or load must not exceed maximum load given in column XV, page 191.

7″ I BEAM—No. 71 B.

17.5 POUNDS PER FOOT.

Flange width	3.76	Area in square inches	5.15
Web thickness	0.35	Resistance	11.31

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Loads as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	10.05	.09	33.5	26.8	22.3	19.1
7	8.62	.12	24.6	19.7	16.4	14.1
8	7.54	.16	18.9	15.1	12.6	10.8
9	6.70	.20	14.9	11.9	9.9	8.5
10	6.03	.24	12.1	9.6	8.0	6.9
11	5.48	.30	10.0	8.0	6.6	5.7
12	5.03	.35	8.4	6.7	5.6	4.8
13	4.64	.41	7.1	5.7	4.8	4.1
14	4.31	.48	6.2	4.9	4.1	3.5
15	4.02	.55	5.4	4.3	3.6	3.1
16	3.77	.63	4.7	3.8	3.1	2.7
17	3.55	.71	4.2	3.3	2.8	2.4
18	3.35	.79	3.7	3.0	2.5	2.1
19	3.17	.88	3.3	2.7	2.2	1.9
20	3.02	.98	3.0	2.4	2.0	1.7
21	2.87	1.08	2.7	2.2	1.8	1.6
22	2.74	1.19	2.5	2.0	1.7	1.4
23	2.62	1.30	2.3	1.8	1.5	1.3
24	2.51	1.41	2.1	1.7	1.4	1.2
25	2.41	1.53	1.9	1.5	1.3	1.1
26	2.32	1.66	1.8	1.4	1.2	1.0
27	2.23	1.79	1.7	1.3	1.1	.9
28	2.15	1.92	1.5	1.2	1.0	.9
29	2.08	2.06	1.4	1.1	1.0	.8

7″ I BEAM—No. 72 B.

20 POUNDS PER FOOT.

Flange width	3.86	Area in square inches	5.88
Web thickness	0.45	Resistance	12.16

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	Greatest Safe Load in Net Tons.	Deflection in Inches.	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.* 100 Pounds per Square Foot.	125 Pounds per Square Foot.	150 Pounds per Square Foot.	175 Pounds per Square Foot.
6	10.81	.09	36.0	28.8	24.0	20.6
7	9.26	.12	26.5	21.2	17.6	15.1
8	8.11	.16	20.3	16.2	13.5	11.6
9	7.20	.20	16.0	12.8	10.7	9.1
10	6.48	.24	13.0	10.4	8.6	7.4
11	5.89	.30	10.7	8.6	7.1	6.1
12	5.40	.35	9.0	7.2	6.0	5.1
13	4.99	.41	7.7	6.1	5.1	4.4
14	4.63	.48	6.6	5.3	4.4	3.8
15	4.32	.55	5.8	4.6	3.8	3.3
16	4.06	.63	5.1	4.1	3.4	2.9
17	3.81	.71	4.5	3.6	3.0	2.6
18	3.60	.79	4.0	3.2	2.7	2.3
19	3.41	.88	3.6	2.9	2.4	2.1
20	3.24	.98	3.2	2.6	2.2	1.9
21	3.09	1.08	2.9	2.4	2.0	1.7
22	2.95	1.19	2.7	2.1	1.8	1.5
23	2.82	1.30	2.5	2.0	1.6	1.4
24	2.70	1.41	2.3	1.8	1.5	1.3
25	2.59	1.53	2.1	1.7	1.4	1.2
26	2.49	1.66	1.9	1.5	1.3	1.1
27	2.40	1.79	1.8	1.4	1.2	1.0
28	2.32	1.92	1.7	1.3	1.1	.9
29	2.24	2.06	1.5	1.2	1.0	.9

6″ I BEAM—No. 60 B.

12.25 POUNDS PER FOOT.

Flange width 3.33
Web thickness 23

Area in square inches. 3.60
Resistance. 7.36

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	6.55	.10	21.8	17.5	14.6	12.5
7	5.61	.14	16.0	12.8	10.7	9.2
8	4.91	.18	12.3	9.8	8.2	7.0
9	4.36	.23	9.7	7.8	6.5	5.5
10	3.93	.29	7.9	6.3	5.2	4.5
11	3.57	.35	6.5	5.2	4.3	3.7
12	3.27	.41	5.5	4 4	3.6	3.1
13	3.02	.48	4.6	3.7	3.1	2.7
14	2.81	.56	4.0	3.2	2.7	2.3
15	2.62	.64	3.5	2.8	2.3	2.0
16	2.45	.73	3.1	2.5	2.0	1.8
17	2.31	.83	2.7	2.2	1.8	1.6
18	2.18	.93	2.4	1.9	1.6	1.4
19	2.07	1.03	2.2	1.7	1.5	1.2
20	1.96	1.14	2.0	1.6	1.3	1.1
21	1.87	1.26	1.8	1.4	1.2	1.0
22	1.79	1.38	1.6	1.3	1.1	.9
23	1.71	1.51	1.5	1.2	1.0	.8
24	1.64	1.65	1.4	1.1	.9	.8
25	1.57	1.79	1.3	1.0	.8	.7
26	1.51	1.93	1.2	.9	.8	.7
27	1.45	2.08	1.1	.9	.7	.6
28	1.40	2.24	1.0	.8	.7	.6
29	1.35	2.40	.9	.7	.6	.5

6″ I BEAM—No. 61 B.

14.75 POUNDS PER FOOT.

Flange width	3.44	Area in square inches	4.34
Web thickness	0.34	Resistance	8.09

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	7.19	.10	24.0	19.2	16.0	13.7
7	6.17	.14	17.6	14.1	11.8	10.1
8	5.40	.18	13.5	10.8	9.0	7.7
9	4.80	.23	10.7	8.5	7.1	6.1
10	4.32	.29	8.6	6.9	5.8	4.9
11	3.92	.35	7.1	5.7	4.8	4.1
12	3.60	.41	6.0	4.8	4.0	3.4
13	3.32	.48	5.1	4.1	3.4	2.9
14	3.08	.56	4.4	3.5	2.9	2.5
15	2.88	.64	3.8	3.1	2.6	2.2
16	2.70	.73	3.4	2.7	2.3	1.9
17	2.54	.83	3.0	2.4	2.0	1.7
18	2.40	.93	2.7	2.1	1.8	1.5
19	2.27	1.03	2.4	1.9	1.6	1.4
20	2.16	1.14	2.2	1.7	1.4	1.2
21	2.06	1.26	2.0	1.6	1.3	1.1
22	1.96	1.38	1.8	1.4	1.2	1.0
23	1.88	1.51	1.6	1.3	1.1	.9
24	1.80	1.65	1.5	1.2	1.0	.9
25	1.73	1.79	1.4	1.1	.9	.8
26	1.66	1.93	1.3	1.0	.9	.7
27	1.60	2.08	1.2	.9	.8	.7
28	1.54	2.24	1.1	.9	.7	.6
29	1.49	2.40	1.0	.8	.7	.6

6″ I BEAM—No. 62 B.

17.25 POUNDS PER FOOT.

Flange width	3.56	Area in square inches	5.07
Web thickness	0.46	Resistance	8.83

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
6	7.85	.10	26.2	20.9	17.4	15.0
7	6.73	.14	19.2	15.4	12.8	11.0
8	5.89	.18	14.7	11.8	9.8	8.4
9	5.23	.23	11.6	9.3	7.7	6.6
10	4.71	.29	9.4	7.5	6.3	5.4
11	4.28	.35	7.8	6.2	5.2	4.4
12	3.93	.41	6.6	5 2	4.4	3.7
13	3.62	.48	5.6	4.5	3.7	3.2
14	3.37	.56	4.8	3.9	3.2	2.8
15	3.14	.64	4.2	3.3	2.8	2.4
16	2.94	.73	3.7	2.9	2.5	2.1
17	2.77	.83	3.3	2.6	2.2	1.9
18	2.62	.93	2.9	2.3	1.9	1.7
19	2.48	1.03	2.6	2.1	1.7	1.5
20	2.36	1.14	2.4	1.9	1.6	1.3
21	2.24	1.26	2.1	1.7	1.4	1.2
22	2.14	1.38	1.9	1.6	1.3	1.1
23	2.05	1.51	1.8	1.4	1.2	1.0
24	1.96	1.65	1.6	1.3	1.1	.9
25	1.88	1.79	1.5	1.2	1.0	.9
26	1.81	1.93	1.4	1.1	.9	.8
27	1.74	2.08	1.3	1.0	.9	.7
28	1.68	2.24	1.2	1 0	.8	.7
29	1.62	2.40	1.1	.9	.7	.6

6″ I BEAM.—No. 63 B.

LEAST SECTION.

32.3 POUNDS PER FOOT.

Flange width	4.87	Area in square inches	9.49
Web thickness	.50	Resistance	17.26

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	Greatest Safe Load in Net Tons.	Addition to Safe Load for Each Lb. per Foot Increase.	Deflection in Inches.	Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.				Divide by Load per Sq. Ft. and Add to Correspond'g Dist. for Each Pound per Ft. Increase of Beam.
				100 Pounds per Sq. Foot.	125 Pounds per Sq. Foot.	150 Pounds per Sq. Foot.	175 Pounds per Sq. Foot.	
6	15.35	.26	.10	51.2	40.9	34.1	29.2	87.11
7	13.15	.23	.14	37.6	30.1	25.0	21.5	64.00
8	11.51	.20	.18	28.8	23.0	19.2	16.4	49.00
9	10.23	.17	.23	22.7	18.2	15.2	13.0	38.72
10	9.21	.16	.29	18.4	14.7	12.3	10.5	31.36
11	8.37	.14	.35	15.2	12.2	10.1	8.7	25.92
12	7.67	.13	.41	12.8	10.2	8.5	7.3	21.78
13	7.08	.12	.48	10.9	8.7	7.3	6.2	18.56
14	6.58	.11	.56	9.4	7.5	6.3	5.4	16.00
15	6 14	.10	.64	8.2	6.6	5.5	4.7	13.94
16	5.75	.10	.73	7.2	5.8	4.8	4.1	12.25
17	5.42	.09	.83	6.4	5.1	4.3	3.6	10.85
18	5.12	.09	.93	5.7	4.6	3.8	3.3	9.68
19	4.85	.08	1.03	5.1	4.1	3.4	2.9	8.69
20	4.60	.08	1.14	4.6	3.7	3.1	2.6	7.84
21	4.38	.08	1.26	4.2	3.3	2.8	2.4	7.11
22	4.19	.07	1.38	3.8	3.0	2.5	2.2	6 48
23	4.00	.07	1.51	3.5	2.8	2.3	2.0	5.93
24	3.84	.06	1.65	3.2	2.6	2.1	1.8	5.44
25	3.68	.06	1.79	2.9	2.4	2.0	1.7	5.02
26	3.54	.06	1.93	2.7	2.2	1.8	1.6	4.64
27	3.41	.06	2.08	2.5	2.0	1.7	1.4	4.30
28	3.29	.05	2.24	2.4	1.9	1.6	1.3	4.00
29	3.17	.05	2.40	2.2	1.7	1.5	1.2	3.73

6″ I BEAM—No. 63 B.

GREATEST SECTION.

37.4 POUNDS PER FOOT.

Flange width . . . . 5.13 | Area in square inches 10.99
Web thickness . . . . .75 | Resistance 18.76

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Addition to Safe Load for Each Lb. per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Loads as Below.*				*Divide by Load per Sq. Ft. and Add to Correspond'g Dist. for Each Pound per Ft. Increase of Beam.*
				100 *Pounds per Sq. Foot.*	125 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	175 *Pounds per Sq. Foot.*	
6	16.68	.26	.10	55.6	44.5	37.1	31.8	87.11
7	14.30	.23	.14	40.9	32.7	27.2	23.4	64.00
8	12.51	.20	.18	31.3	25.0	20.8	17.9	49.00
9	11.12	.17	.23	24.7	19.8	16.5	14.1	38.72
10	10.01	.16	.29	20.0	16.0	13.3	11.4	31.36
11	9.10	.14	.35	16.5	13.2	11.0	9.5	25.92
12	8.34	.13	.41	13.9	11.1	9.3	7.9	21.78
13	7.70	.12	.48	11.8	9.5	7.9	6.8	18.56
14	7.15	.11	.56	10.2	8.2	6.8	5.8	16.00
15	6.67	.10	.64	8.9	7.1	5.9	5.1	13.94
16	6.25	.10	.73	7.8	6.3	5.2	4.5	12.25
17	5.89	.09	.83	6.9	5.5	4.6	4.0	10.85
18	5.56	.09	.93	6.2	4.9	4.1	3.5	9.68
19	5.27	.08	1.03	5.5	4.4	3.7	3.2	8.69
20	5.00	.08	1.14	5.0	4.0	3.3	2.9	7.84
21	4.77	.08	1.26	4.5	3.6	3.0	2.6	7.11
22	4.55	.07	1.38	4.1	3.3	2.8	2.4	6.48
23	4.35	.07	1.51	3.8	3.0	2.5	2.2	5.93
24	4.17	.06	1.65	3.5	2.8	2.3	2.0	5.44
25	4.00	.06	1.79	3.2	2.6	2.1	1.8	5.02
26	3.85	.06	1.93	3.0	2.4	2.0	1.7	4.64
27	3.71	.06	2.08	2.7	2.2	1.8	1.6	4.30
28	3.57	.05	2.24	2.6	2.0	1.7	1.5	4.00
29	3.45	.05	2.40	2.4	1.9	1.6	1.4	3.73

6″ I BEAM.—No. 67 B.

LEAST SECTION.

41.0 POUNDS PER FOOT.

Flange width	5.25	Area in square inches	12.06
Web thickness	0.63	Resistance	21.29

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Addition to Safe Load for Each Lb. per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*				*Divide by Load per Sq. Ft. and Add to Correspond'g Dist. for Each Pound per Ft. Increase of Beam.*
				100 *Pounds per Sq. Foot.*	125 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	175 *Pounds per Sq. Foot.*	
6	18.93	.26	.10	63.1	50.5	42.1	36.1	87.11
7	16.22	.22	.14	46.3	37.1	30.9	26.5	64.00
8	14.19	.20	.18	35.5	28.4	23.7	20.3	49.00
9	12.62	.17	.23	28.0	22.4	18.7	16.0	38.72
10	11.36	.16	.29	22.7	18.2	15.1	13.0	31.36
11	10.32	.14	.35	18.8	15.0	12.5	10.7	25.92
12	9.46	.13	.41	15.8	12.6	10.5	9.0	21.78
13	8.73	.12	.48	13.4	10.7	9.0	7.7	18.56
14	8.11	.11	.56	11.6	9.3	7.7	6.6	16.00
15	7.57	.10	.64	10.1	8.1	6.7	5.8	13.94
16	7.10	.10	.73	8.9	7.1	5.9	5.1	12.25
17	6.68	.09	.83	7.9	6.3	5.2	4.5	10.85
18	6.31	.09	.93	7.0	5.6	4.7	4.0	9.68
19	5.98	.08	1.03	6.3	5.0	4.2	3.6	8.69
20	5.68	.08	1.14	5.7	4.5	3.8	3.2	7.84
21	5.41	.07	1.26	5.2	4.1	3.4	2.9	7.11
22	5.16	.07	1.38	4.7	3.8	3.1	2.7	6.48
23	4.94	.07	1.51	4.3	3.4	2.9	2.5	5.93
24	4.73	.06	1.65	3.9	3.2	2.6	2.3	5.44
25	4.54	.06	1.79	3.6	2.9	2.4	2.1	5.02
26	4.37	.06	1.93	3.4	2.7	2.2	1.9	4.64
27	4.21	.06	2.08	3.1	2.5	2.1	1.8	4.30
28	4.06	.05	2.24	2.9	2.3	1.9	1.7	4.00
29	3.92	.05	2.40	2.7	2.2	1.8	1.5	3.73

6″ I BEAM—No. 67 B.

GREATEST SECTION.

46.1 POUNDS PER FOOT.

Flange width	5.50	Area in square inches	13.56
Web thickness	0.88	Resistance	22.79

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Addition to Safe Load for Each Lb. per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*				*Divide by Load per Sq. Ft. and Add to Correspond'g Dist. for Each Pound per Ft. Increase of Beam.*
				100 *Pounds per Sq. Foot.*	125 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	175 *Pounds per Sq. Foot.*	
6	20.26	.26	.10	67.5	54.0	45.0	38.6	87.11
7	17.36	.22	.14	49.6	39.7	33.1	28.3	64.00
8	15.19	.20	.18	38.0	30.4	25.3	21.7	49.00
9	13.51	.17	.23	30.0	24.0	20.0	17.2	38.72
10	12.16	.16	.29	24.3	19.5	16.2	13.9	31.36
11	11.05	.14	.35	20.1	16.1	13.4	11.5	25.92
12	10.13	.13	.41	16.9	13.5	11.3	9.6	21.78
13	9.35	.12	.48	14.4	11.5	9.6	8.2	18.56
14	8.68	.11	.56	12.4	9.9	8.3	7.1	16.00
15	8.10	.10	.64	10.8	8.6	7.2	6.2	13.94
16	7.60	.10	.73	9.5	7.6	6.3	5.4	12.25
17	7.15	.09	.83	8.4	6.7	5.6	4.8	10.85
18	6.75	.09	.93	7.5	6.0	5.0	4.3	9.68
19	6.40	.08	1.03	6.7	5.4	4.5	3.9	8.69
20	6.08	.08	1.14	6.1	4.9	4.1	3.5	7.84
21	5.79	.07	1.26	5.5	4.4	3.7	3.2	7.11
22	5.53	.07	1.38	5.0	4.0	3.4	2.9	6 48
23	5.28	.07	1.51	4.6	3.7	3.1	2.6	5.93
24	5.06	.06	1.65	4.2	3.4	2.8	2.4	5.44
25	4.86	.06	1.79	3.9	3.1	2.6	2.2	5.02
26	4.68	.06	1.93	3.6	2.9	2.4	2.1	4.64
27	4.50	.06	2.08	3.3	2.7	2.2	1.9	4.30
28	4.34	.05	2.24	3.1	2 5	2.1	1.8	4.00
29	4.19	.05	2.40	2.9	2.3	1.9	1.7	3.73

5″ I BEAM—No. 50 B.

9.75 POUNDS PER FOOT.

Flange width	3.00	Area in square inches	2.87
Web thickness	.21	Resistance	4.85

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
4	*6.48*	.05	32.4	25.9	21.6	18.5
5	5.17	.09	20.7	16.5	13.8	11.8
6	4.31	.12	14.4	11.5	9.6	8.2
7	3.69	.17	10.5	8.4	7.0	6.0
8	3.23	.22	8.1	6.5	5.4	4.6
9	2.87	.28	6.4	5.1	4.3	3.6
10	2.59	.34	5.2	4.1	3.5	3.0
11	2.35	.41	4.3	3.4	2.8	2.4
12	2.16	.49	3.6	2.9	2.4	2.1
13	1.99	.58	3.1	2.4	2.0	1.8
14	1.85	.67	2.6	2.1	1.8	1.5
15	1.72	.77	2.3	1.8	1.5	1.3

5″ I BEAM—No. 51 B.

12.25 POUNDS PER FOOT.

Flange width	3.14	Area in square inches	3.60
Web thickness	.35	Resistance	5.46

4	7.29	.05	36.5	29.2	24.3	20.8
5	5.83	.09	23.3	18.7	15.5	13.3
6	4.86	.12	16.2	13.0	10.8	9.3
7	4.16	.17	11.9	9.5	7.9	6.8
8	3.64	.22	9.1	7.3	6.1	5.2
9	3.24	.28	7.2	5.8	4.8	4.1
10	2.91	.34	5.8	4.7	3.9	3.3
11	2.65	.41	4.8	3.9	3.2	2.8
12	2.43	.49	4.1	3.2	2.7	2.3
13	2.24	.58	3.4	2.8	2.3	2.0
14	2.08	.67	3.0	2.4	2.0	1.7
15	1.94	.77	2.6	2.1	1.7	1 5

N. B.—For loads given in Italics webs must be stiffened, or loads must not exceed maximum loads given in column XV, page 191.

5″ I BEAM—No. 52 B.

14.75 POUNDS PER FOOT.

Flange width	3.28	Area in square inches	4.34
Web thickness	0.49	Resistance	6.07

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
4	8.10	.05	40.5	32.4	27.0	23.1
5	6.48	.09	25.9	20.7	17.3	14.8
6	5.40	.12	18.0	14.4	12.0	10.3
7	4.63	.17	13.2	10.6	8.8	7.6
8	4.05	.22	10.1	8.1	6.8	5.8
9	3.60	.28	8.0	6.4	5.3	4.6
10	3.24	.34	6.5	5.2	4.3	3.7
11	2.94	.41	5.3	4.3	3.6	3.1
12	2.70	.49	4.5	3.6	3.0	2.6
13	2.49	.58	3.8	3.1	2.6	2.2
14	2.31	.67	3.3	2.6	2.2	1.9
15	2.16	.77	2.9	2.3	1.9	1.6
16	2.02	.88	2.5	2.0	1.7	1.4
17	1.90	.99	2.2	1.8	1.5	1.3
18	1.80	1.11	2.0	1.6	1.3	1.1
19	1.70	1.24	1.8	1.4	1.2	1.0
20	1.62	1.37	1.6	1.3	1.1	.9
21	1.54	1.51	1.5	1.2	1.0	.8
22	1.47	1.66	1.3	1.1	.9	.8
23	1.41	1.81	1.2	1.0	.8	.7
24	1.35	1.97	1.1	.9	.8	.6
25	1.30	2.14	1.0	.8	.7	.6
26	1.25	2.32	1.0	.8	.6	.5
27	1.20	2.50	.9	.7	.6	.5

4″ I BEAM—No. 40 B.

7.5 POUNDS PER FOOT.

Flange width	2.66	Area in square inches	2.20
Web thickness	.19	Resistance	2.95

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
4	3.93	.07	19.7	15.7	13.1	11.2
5	3.15	.11	12.6	10.1	8.4	7.2
6	2.62	.15	8.7	7.0	5.8	5.0
7	2.25	.21	6.4	5.1	4.3	3.7
8	1.97	.27	4.9	3.9	3.3	2.8
9	1.75	.35	3.9	3.1	2.6	2.2
10	1.57	.43	3.1	2.5	2.1	1.8
11	1.43	.52	2.6	2.1	1.7	1.5
12	1.31	.62	2.2	1.7	1.5	1.2
13	1.21	.72	1.9	1.5	1.2	1.1
14	1.12	.84	1.6	1.3	1.1	.9
15	1.05	.96	1.4	1.1	.9	.8

4″ I BEAM—No. 41 B.

8.5 POUNDS PER FOOT.

Flange width	2.72	Area in square inches	2.50
Web thickness	.25	Resistance	3.15

4	4.19	.07	21.0	16.8	14.0	12.0
5	3.36	.11	13.4	10.8	9.0	7.7
6	2.80	.15	9.3	7.5	6.2	5.3
7	2.40	.21	6.9	5.5	4.6	3.9
8	2.10	.27	5.3	4.2	3.5	3.0
9	1.86	.35	4.1	3.3	2.8	2.4
10	1.68	.43	3.4	2.7	2.2	1.9
11	1.52	.52	2.8	2.2	1.8	1.6
12	1.40	.62	2.3	1.9	1.6	1.3
13	1.29	.72	2.0	1.6	1.3	1.1
14	1.20	.84	1.7	1.4	1.1	1.0
15	1.12	.96	1.5	1.2	1.0	.9

4″ I BEAM—No. 42 B.

9.5 POUNDS PER FOOT.

Flange width . . . . 2.79 | Area in square inches. 2.79
Web thickness . . . . .32 | Resistance. 3.34

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
4	4.45	.07	22.3	17.8	14.8	12.7
5	3.56	.11	14.2	11.4	9.5	8.1
6	2.97	.15	9.9	7.9	6.6	5.7
7	2.55	.21	7.3	5.8	4.9	4.2
8	2.23	.27	5.6	4.5	3.7	3.2
9	1.98	.35	4.4	3.5	2.9	2.5
10	1.78	.43	3.6	2.8	2.4	2.0
11	1.62	.52	2.9	2.4	2.0	1.7
12	1.48	.62	2.5	2.0	1.6	1.4
13	1.37	.72	2.1	1.7	1.4	1.2
14	1.27	.84	1.8	1.5	1.2	1.0
15	1.19	.96	1.6	1.3	1.1	.9

4″ I BEAM—No. 43 B.

10.5 POUNDS PER FOOT.

Flange width. . . . . 2.86 | Area in square inches 3.09
Web thickness . . . . .39 | Resistance. 3.54

4	4.71	.07	23.6	18.8	15.7	13.5
5	3.77	.11	15.1	12.1	10.1	8.6
6	3.14	.15	10.5	8.4	7.0	6.0
7	2.69	.21	7.7	6.2	5.1	4.4
8	2.36	.27	5.9	4.7	3.9	3.4
9	2.09	.35	4.6	3.7	3.1	2.7
10	1.89	.43	3.8	3.0	2.5	2.2
11	1.71	.52	3.1	2.5	2.1	1.8
12	1.57	.62	2.6	2.1	1.8	1.5
13	1.45	.72	2.2	1.8	1.5	1.3
14	1.35	.84	1.9	1.5	1.3	1.1
15	1.26	.96	1.7	1.3	1.1	1.0

3″ I BEAM—No. 30 B.

5.5 POUNDS PER FOOT.

Flange width	2.33	Area in square inches	1.62
Web thickness	0.17	Resistance	1.62

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
4	2.16	.09	10.8	8.6	7.2	6.2
5	1.73	.14	6.9	5.5	4.6	4.0
6	1.44	.21	4.8	3.8	3.2	2.7
7	1.23	.28	3.5	2.8	2.3	2.0
8	1.08	.37	2.7	2.2	1.8	1.5
9	.96	.46	2.1	1.7	1.4	1.2
10	.86	.57	1.7	1.4	1.1	1.0
11	.79	.69	1.4	1.1	1.0	.8
12	.72	.82	1.2	1.0	.8	.7
13	.66	.97	1.0	.8	.7	.6
14	.62	1.12	.9	.7	.6	.5
15	.58	1.29	.8	.6	.5	.4

3″ I BEAM—No. 31 B.

6.5 POUNDS PER FOOT.

Flange width	2.40	Area in square inches	1.91
Web thickness	0.24	Resistance	1.76

4	2.35	.09	11.8	9.4	7.8	6.7
5	1.88	.14	7.5	6.0	5.0	4.3
6	1.57	.21	5.2	4.2	3.5	3.0
7	1.34	.28	3.8	3.1	2.6	2.2
8	1.17	.37	2.9	2.3	2.0	1.7
9	1.04	.46	2.3	1.8	1.5	1.3
10	.94	.57	1.9	1.5	1.3	1.1
11	.85	.69	1.5	1.2	1.0	.9
12	.78	.82	1.3	1.0	.9	.7
13	.72	.97	1.1	.9	.7	.6
14	.67	1.12	1.0	.8	.6	.5
15	.63	1.29	.8	.7	.6	.5

3″ I BEAM—No. 32 B.

7.5 POUNDS PER FOOT.

Flange width	2.50	Area in square inches	2.20
Web thickness	0.34	Resistance	1.91

Greatest safe load in net tons uniformly distributed. Fibre stress 16,000 lbs.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
For figures in small type deflection is excessive.

Span in Feet.	*Greatest Safe Load in Net Tons.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams for Distributed Load as Below.*			
			100 *Pounds per Square Foot.*	125 *Pounds per Square Foot.*	150 *Pounds per Square Foot.*	175 *Pounds per Square Foot.*
4	2.55	.09	12.8	10.2	8.5	7.3
5	2.04	.14	8.2	6.5	5.4	4.7
6	1.70	.21	5.7	4.5	3.8	3.2
7	1.46	.28	4.2	3.3	2.8	2.4
8	1.28	.37	3.2	2.6	2.1	1.8
9	1.13	.46	2.5	2.0	1.7	1.4
10	1.02	.57	2.0	1.6	1.4	1.2
11	.93	.69	1.7	1.4	1.1	1.0
12	.85	.82	1.4	1.1	.9	.8
13	.78	.97	1.2	1.0	.8	.7
14	.73	1.12	1.0	.8	.7	.6
15	.68	1.29	.9	.7	.6	.5

PENCOYD CHANNELS.

Greatest safe loads in net tons evenly distributed, including beam itself.
For concentrated load in middle of beam take one half amount in table.

Size in Inches.	*Section Number.*	*Weight per Foot in Pounds.*	*Length of Span in Feet.*							
			8	9	10	11	12	13	14	15
			Safe Load in Net Tons.							
15	150C	33.0	*27.66*	*24.59*	22.13	20.12	18.44	17.02	15.81	14.75
15	151C	35.0	*28.66*	25.48	22.93	20.85	19.11	17.64	16.38	15.29
15	152C	40.0	31.11	27.66	24.89	22.63	20.74	19.15	17.78	16.59
15	153C	45.0	33.56	29.83	26.85	24.41	22.38	20.65	19.18	17.90
15	154C	50.0	39.32	34.95	31.45	28.59	26.21	24.19	22.47	20.97
15	155C	55.0	41.76	37.12	33.41	30.37	27.84	25.70	23.87	22.27
			.07	.09	.11	.14	.16	.19	.22	.26
12	120C	20.5	*14.36*	*12.77*	11.49	10.45	9.58	8.84	8.21	7.66
12	121C	25.0	16.12	14.33	12.90	11.73	10.75	9.92	9.21	8.60
12	122C	30.0	18.09	16.08	14.47	13.16	12.06	11.13	10.34	9.65
12	123C	35.0	23.08	20.51	18.46	16.78	15.38	14.20	13.19	12.31
12	124C	40.0	25.03	22.25	20.02	18.20	16.69	15.40	14.30	13.35
12	128C	20.5	*13.78*	*12.24*	11.02	10.02	9.18	8.48	7.87	7.35
12	128C	32.0	18.26	16.23	14.60	13.28	12.17	11.23	10.43	9.74
			.09	.12	.14	.17	.21	.24	.28	.32
10	100C	15.0	*8.94*	7.95	7.16	6.51	5.97	5.51	5.11	4.77
10	101C	20.0	10.58	9.41	8.47	7.70	7.05	6.51	6.05	5.64
10	102C	25.0	13.35	11.87	10.68	9.71	8.90	8.21	7.63	7.12
10	103C	30.0	14.98	13.32	11.99	10.90	9.99	9.22	8.56	7.99
10	104C	35.0	16.61	14.77	13.29	12.08	11.08	10.22	9.49	8.86
			.11	.14	.17	.21	.25	.29	.34	.39
9	90C	13.25	7.10	6.31	5.68	5.16	4.73	4.37	4.05	3.78
9	91C	15.0	7.61	6.76	6.09	5.53	5.07	4.68	4.35	4.06
9	92C	20.0	9.92	8.82	7.94	7.22	6.61	6.11	5.67	5.29
9	93C	25.0	11.40	10.13	9.12	8.29	7.60	7.01	6.51	6.08
			.12	.15	.19	.23	.27	.32	.37	.43

N. B.—For loads given in italics webs must be stiffened or loads must not exceed maximum loads given col. XVI, page 193.

PENCOYD CHANNELS.

Small figures give deflection in inches for loads above. For one half load at centre reduce deflection one-fifth. Deflection below black line is excessive.

Length of Span in Feet.									Size in Inches.
16	18	20	22	24	26	28	30	32	
Safe Load in Net Tons.									
13.83	12.29	11.07	10.06	9.22	8.51	7.90	7.38	6.92	15
14.33	12.74	11.47	10.42	9.55	8.82	8.19	7.64	7.17	15
15.56	13.83	12.45	11.31	10.37	9.57	8.89	8.30	7.78	15
16.78	14.92	13.43	12.20	11.19	10.33	9.59	8.95	8.39	15
19.66	17.47	15.73	14.30	13.11	12.10	11.23	10.48	9.83	15
20.88	18.56	16.71	15.19	13.92	12.85	11.93	11.14	10.44	15
.29	.37	.46	.55	.66	.77	.90	1.0	1.2	
7.18	6.38	5.75	5.22	4.79	4.42	4.10	3.83	3.59	12
8.06	7.17	6.45	5.86	5.37	4.96	4.61	4.30	4.03	12
9.05	8.04	7.24	6.58	6.03	5.57	5.17	4.83	4.52	12
11.54	10.26	9.23	8.39	7.69	7.10	6.59	6.15	5.77	12
12.51	11.12	10.01	9.10	8.34	7.70	7.15	6.67	6.26	12
6.89	6.12	5.51	5.01	4.59	4.24	3.94	3.67	3.44	12
9.13	8.11	7.30	6.64	6.09	5.62	5.22	4.87	4.56	12
.37	.46	.57	.69	.82	.97	1.1	1.3	1.5	
4.47	3.98	3.58	3.25	2.98	2.75	2.56	2.39	2.24	10
5.29	4.70	4.23	3.85	3.53	3.26	3.02	2.82	2.65	10
6.67	5.93	5.34	4.85	4.45	4.11	3.81	3.56	3.34	10
7.49	6.66	5.99	5.45	4.99	4.61	4.28	4.00	3.75	10
8.31	7.38	6.65	6.04	5.54	5.11	4.75	4.43	4.15	10
.44	.56	.69	.83	.99	1.2	1.3	1.5	1.8	
3.55	3.15	2.84	2.58	2.37	2.18	2.03	1.89	1.77	9
3.80	3.38	3.04	2.77	2.54	2.34	2.17	2.03	1.90	9
4.96	4.41	3.97	3.61	3.31	3.05	2.83	2.65	2.48	9
5.70	5.07	4.56	4.14	3.80	3.51	3.26	3.04	2.85	9
.49	.62	.76	.92	1.1	1.3	1.5	1.7	2.0	

PENCOYD CHANNELS.

Greatest safe distributed load in net tons including beam. Small figures give deflection in inches for loads above. For one-half load at centre reduce deflection one-fifth. Deflection below black line is excessive.

Size in Inches.	*Section Number.*	*Weight in Pounds per Foot.*	*Length of Span in Feet.* 5	6	7	8	10	12	14	16
			Safe Load in Net Tons.							
8	80C	11.25	*8.68*	*7.23*	6.19	5.42	4.33	3.61	3.10	2.71
8	81C	13.75	9.71	8.10	6.94	6.07	4.86	4.05	3.47	3.04
8	82C	16.25	11.73	9.78	8.38	7.33	5.87	4.89	4.19	3.67
8	83C	18.75	12.78	10.65	9.13	7.99	6.39	5.33	4.56	3.99
8	84C	21.25	13.83	11.52	9.88	8.64	6.91	5.76	4.94	4.32
			.05	.08	.10	.14	.21	.31	.42	.55
7	70C	9.75	6.51	5.43	4.65	4.07	3.26	2.71	2.33	2.04
7	71C	12.25	7.43	6.19	5.31	4.64	3.71	3.09	2.65	2.32
7	72C	14.75	9.10	7.58	6.50	5.69	4.55	3.79	3.25	2.84
7	73C	17.25	10.01	8.34	7.15	6.26	5.01	4.17	3.58	3.13
7	74C	19.75	10.92	9.10	7.80	6.83	5.46	4.55	3.90	3.41
			.06	.09	.12	.16	.24	.35	.48	.63
6	60C	8.00	4.65	3.87	3.32	2.90	2.32	1.94	1.66	1.45
6	61C	10.50	5.77	4.81	4.12	3.61	2.89	2.40	2.06	1.80
6	62C	13.00	6.55	5.46	4.68	4.10	3.28	2.73	2.34	2.05
6	63C	15.50	7.34	6.12	5.24	4.59	3.67	3.06	2.62	2.29
			.07	.10	.14	.18	.29	.41	.56	.73
5	50C	6.50	3.14	2.62	2.25	1.97	1.57	1.31	1.12	.98
5	51C	9.00	3.80	3.16	2.71	2.37	1.90	1.58	1.36	1.19
5	52C	11.50	4.45	3.71	3.18	2.78	2.23	1.85	1.59	1.39
			.09	.12	.17	.22	.34	.49	.67	.88
4	40C	5.25	1.99	1.66	1.42	1.25	1.00	.83	.71	.62
4	41C	6.25	2.20	1.84	1.57	1.38	1.10	.92	.79	.69
4	42C	7.25	2.41	2.01	1.72	1.51	1.21	1.00	.86	.75
			.11	.15	.21	.27	.43	.62	.84	1.1
3	30C	4.00	1.14	.95	.82	.72	.57	.48	.41	.36
3	31C	5.00	1.30	1.08	.93	.81	.65	.54	.46	.41
3	32C	6.00	1.46	1.21	1.04	.91	.73	.61	.52	.46
			.14	.21	.28	.37	.57	.82	1.1	1.4

N. B.—For loads given in italics webs must be stiffened or loads must not exceed maximum loads given col. XVI, page 195.

PENCOYD CHANNELS.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

When the force acts in the direction of the flanges or at right angles to the web.

Fibre Stress 16,000 lbs. per Square Inch.

Size in Ins.	*Sec. No.*	*Wt. in Lbs. per Foot.*	*Length of Span in Feet.*									
			4	5	6	7	8	9	10	11	12	13
			Safe Load in Net Tons.									
15	150C	33.0	4.14	3.31	2.76	2.36	2.07	1.84	1.66	1.50	1.38	1.27
15	151C	35.0	4.28	3.42	2.85	2.45	2.14	1.90	1.71	1.56	1.43	1.32
15	152C	40.0	4.56	3.65	3.04	2.61	2.28	2.03	1.82	1.66	1.52	1.40
15	153C	45.0	4.83	3.86	3.22	2.76	2.41	2.15	1.93	1.76	1.61	1.49
15	154C	50.0	6.92	5.53	4.61	3.95	3.46	3.07	2.77	2.51	2.31	2.13
15	155C	55.0	7.30	5.84	4.87	4.17	3.65	3.25	2.92	2.66	2.43	2.25
12	120C	20.5	2.32	1.86	1.55	1.33	1.16	1.03	0.93	0.84	0.77	0.71
12	121C	25.0	2.53	2.03	1.69	1.45	1.27	1.13	1.01	0.92	0.84	0.78
12	122C	30.0	2.77	2.22	1.85	1.58	1.39	1.23	1.11	1.01	0.92	0.85
12	123C	35.0	4.76	3.81	3.17	2.72	2.38	2.12	1.90	1.73	1.59	1.46
12	124C	40.0	5.12	4.10	3.41	2.93	2.56	2.28	2.05	1.86	1.71	1.58
10	100C	15.0	1.55	1.24	1.03	0.88	0.77	0.69	0.62	0.56	0.52	0.48
10	101C	20.0	1.77	1.42	1.18	1.01	0.89	0.79	0.71	0.64	0.59	0.54
10	102C	25.0	2.66	2.13	1.77	1.52	1.33	1.18	1.06	0.97	0.89	0.82
10	103C	30.0	2.95	2.36	1.97	1.69	1.47	1.31	1.18	1.07	0.98	0.91
10	104C	35.0	3.26	2.61	2.17	1.86	1.63	1.45	1.30	1.19	1.09	1.00
9	90C	13.25	1.29	1.03	0.86	0.74	0.65	0.57	0.52	0.47	0.43	0.40
9	91C	15.00	1.37	1.10	0.92	0.79	0.69	0.61	0.55	0.50	0.46	0.42
9	92C	20.00	2.08	1.67	1.39	1.19	1.04	0.92	0.83	0.76	0.69	0.64
9	93C	25.00	2.37	1.89	1.58	1.35	1.18	1.05	0.95	0.86	0.79	0.73
8	80C	11.25	1.04	0.83	0.70	0.60	0.52	0.46	0.42	0.38	0.35	0.32
8	81C	13.75	1.16	0.92	0.77	0.66	0.58	0.51	0.46	0.42	0.39	0.36
8	82C	16.25	1.64	1.31	1.09	0.94	0.82	0.73	0.66	0.59	0.55	0.50
8	83C	18.75	1.77	1.42	1.18	1.01	0.89	0.79	0.71	0.64	0.59	0.55
8	84C	21.25	1.90	1.52	1.27	1.09	0.95	0.85	0.76	0.69	0.63	0.59
7	70C	9.75	0.84	0.67	0.56	0.48	0.42	0.37	0.34	0.31	0.28	0.26
7	71C	12.25	0.95	0.76	0.63	0.54	0.47	0.42	0.38	0.34	0.32	0.29
7	72C	14.75	1.37	1.10	0.91	0.78	0.69	0.61	0.55	0.50	0.46	0.42
7	73C	17.25	1.51	1.20	1.00	0.86	0.75	0.67	0.60	0.55	0.50	0.46
7	74C	19.75	1.64	1.31	1.10	0.94	0.82	0.73	0.66	0.60	0.55	0.50
6	60C	8.00	0.65	0.52	0.44	0.37	0.33	0.29	0.26	0.24	0.22	0.20
6	61C	10.50	0.91	0.73	0.61	0.52	0.45	0.41	0.36	0.33	0.30	0.28
6	62C	13.00	1.04	0.83	0.69	0.59	0.52	0.46	0.41	0.38	0.35	0.32
6	63C	15.50	1.16	0.93	0.78	0.66	0.58	0.52	0.46	0.42	0.39	0.36
5	50C	6.50	0.50	0.40	0.33	0.28	0.25	0.22	0.20	0.18	0.16	0.15
5	51C	9.00	0.61	0.49	0.41	0.35	0.30	0.27	0.25	0.22	0.20	0.19
5	52C	11.50	0.72	0.57	0.48	0.41	0.36	0.32	0.29	0.26	0.24	0.22

PENCOYD EVEN ANGLES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

One Leg Vertical.

Fibre Stress 16,000 lbs. per Square Inch.

Size of Angle. Inches.	*Length of Span in Feet.*									
	4	5	6	7	8	9	10	11	12	13
	Safe Load in Net Tons.									
8 x 8 x ½	11.12	8.90	7.41	6.35	5.56	4.94	4.45	4.04	3.71	3.42
8¼ x 8¼ x 1	21.58	17.26	14.38	12.33	10.79	9.59	8.63	7.85	7.19	6.64
6 x 6 x ⅜	4.71	3.77	3.14	2.69	2.35	2.09	1.88	1.71	1.57	1.45
6¼ x 6¼ x $\frac{15}{16}$	11.24	8.99	7.49	6.42	5.62	5.00	4.50	4.09	3.75	3.46
5 x 5 x ⅜	3.23	2.58	2.15	1.84	1.61	1.43	1.29	1.17	1.08	0.99
5¼ x 5¼ x $\frac{15}{16}$	7.68	6.14	5.12	4.39	3.84	3.41	3.07	2.79	2.56	2.36
4 x 4 x $\frac{5}{16}$	1.71	1.37	1.14	0.98	0.85	0.76	0.68	0.62	0.57	0.53
4¼ x 4¼ x ¾	4.13	3.31	2.76	2.36	2.07	1.84	1.65	1.50	1.38	1.27
3½ x 3½ x $\frac{5}{16}$	1.31	1.05	0.87	0.75	0.65	0.58	0.52	0.48	0.44	0.40
3⅝ x 3⅝ x ⅝	2.45	1.96	1.64	1.40	1.23	1.09	0.98	0.89	0.82	0.76
3 x 3 x ¼	0.77	0.62	0.55	0.44	0.39	0.34	0.31	0.28	0.26	0.24
$3\frac{3}{16}$ x $3\frac{3}{16}$ x ⅝	1.85	1.48	1.24	1.06	0.93	0.82	0.74	0.67	0.62	0.57
2¾ x 2¾ x ¼	0.64	0.51	0.43	0.37	0.32	0.28	0.26	0.23	0.21	0.20
3 x 3 x ½	1.36	1.09	0.91	0.78	0.68	0.60	0.54	0.49	0.45	0.42

For angles of intermediate thicknesses the safe loads can be assumed as approximately proportional to their areas or weights.

PENCOYD EVEN ANGLES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

One Leg Vertical.

Fibre Stress 16,000 lbs. per Sq. Inch.

Size of Angle. Inches.	*Length of Span in Feet.*							
	1	2	3	4	5	6	7	8
	Safe Load in Net Tons.							
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{16}$	1.60	0.80	0.53	0.40	0.32	0.27	0.23	0.20
$2\frac{5}{8} \times 2\frac{5}{8} \times \frac{1}{2}$	4.00	2.00	1.33	1.00	0.80	0.67	0.57	0.50
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$	1.28	0.64	0.43	0.32	0.26	0.21	0.18	0.16
$2\frac{7}{16} \times 2\frac{7}{16} \times \frac{3}{8}$	2.67	1.34	0.89	0.67	0.53	0.45	0.38	0.33
$2 \times 2 \times \frac{3}{16}$	1.01	0.51	0.34	0.25	0.20	0.17	0.14	0.126
$2\frac{3}{16} \times 2\frac{3}{16} \times \frac{3}{8}$	2.13	1.07	0.71	0.53	0.43	0.36	0.30	0.266
$1\frac{3}{4} \times 1\frac{3}{4} \times \frac{3}{16}$	0.80	0.40	0.27	0.20	0.16	0.13	0.11	0.100
$1\frac{15}{16} \times 1\frac{15}{16} \times \frac{3}{8}$	1.60	0.80	0.53	0.40	0.32	0.27	0.23	0.200
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$	0.37	0.17	0.12	0.09	0.07	0.06	0.05	0.046
$1\frac{3}{4} \times 1\frac{3}{4} \times \frac{3}{8}$	1.33	0.67	0.44	0.33	0.27	0.22	0.19	0.166
$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{8}$	0.32	0.16	0.11	0.08	0.06	0.05	0.046	0.040
$1\frac{3}{8} \times 1\frac{3}{8} \times \frac{1}{4}$	0.59	0.30	0.20	0.15	0.12	0.10	0.084	0.074
$1 \times 1 \times \frac{1}{8}$	0.16	0.08	0.05	0.04	0.03	0.027	0.023	0.020
$1\frac{1}{8} \times 1\frac{1}{8} \times \frac{1}{4}$	0.37	0.19	0.12	0.09	0.07	0.062	0.053	0.046

For angles of intermediate thicknesses the safe loads can be assumed as approximately proportional to their areas or weights.

PENCOYD UNEVEN ANGLES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Long Leg Vertical.

Fibre Stress 16,000 lbs. per Square Inch.

Size of Angle. Inches.	*Length of Span in Feet.*									
	4	5	6	7	8	9	10	11	12	13
	Safe Load in Net Tons.									
8 x 6 x ½	10.71	8.57	7.14	6.12	5.35	4.76	4.28	3.89	3.57	3.29
8¼ x 6¼ x 1	20.57	16.46	13.72	11.76	10.29	9.14	8.23	7.48	6.86	6.33
7 x 3½ x ½	7.55	6.04	5.03	4.31	3.77	3.35	3.02	2.74	2.52	2.32
7¼ x 3¾ x 1	14.47	11.57	9.65	8.27	7.23	6.43	5.79	5.26	4.82	4.45
6½ x 4 x ⅜	5.16	4.13	3.44	2.95	2.58	2.29	2.06	1.88	1.72	1.59
6⅞ x 4⅜ x $\frac{15}{16}$	12.78	10.23	8.52	7.30	6.39	5.68	5.11	4.65	4.26	3.93
6 x 4 x ⅜	4.43	3.54	2.95	2.53	2.21	1.97	1.77	1.61	1.48	1.36
6⅜ x 4⅜ x $\frac{15}{16}$	10.95	8.76	7.30	6.26	5.47	4.87	4.38	3.98	3.65	3.37
6 x 3½ x ⅜	4.32	3.46	2.88	2.47	2.16	1.92	1.73	1.57	1.44	1.33
6⅜ x 3⅞ x $\frac{15}{16}$	10.73	8.59	7.16	6.13	5.37	4.77	4.29	3.90	3.58	3.30
5½ x 3½ x ⅜	3.68	2.94	2.45	2.10	1.84	1.64	1.47	1.34	1.23	1.13
5¾ x 3¾ x ⅝	6.21	4.97	4.14	3.55	3.11	2.76	2.49	2.26	2.07	1.91
5 x 4 x ⅜	3.12	2.50	2.08	1.78	1.56	1.39	1.25	1.13	1.04	0.96
5$\frac{3}{16}$ x 4$\frac{3}{16}$ x ¾	6.00	4.80	4.00	3.43	3.00	2.67	2.40	2.18	2.00	1.85
5 x 3½ x $\frac{5}{16}$	2.57	2.06	1.72	1.47	1.29	1.14	1.03	0.94	0 86	0.79
5¼ x 3¾ x ¾	6.01	4.81	4.01	3.44	3.01	2.67	2.41	2.19	2.00	1.85
5 x 3 x $\frac{5}{16}$	2.52	2.02	1.68	1.44	1.26	1.12	1.01	0.92	0.84	0.78
5¼ x 3¼ x ¾	5.87	4.69	3.91	3.35	2.93	2.61	2.55	2.13	1.96	1.81
4½ x 3 x $\frac{5}{16}$	2.07	1.65	1.38	1.18	1.03	0.92	0.83	0.75	0.69	0.64
4¾ x 3¼ x ¾	4.81	3.85	3.21	2.75	2.41	2.14	1.93	1.75	1.60	1.48
4 x 3½ x $\frac{5}{16}$	1.69	1.35	1.13	0.97	0.85	0.75	0.68	0.62	0.56	0.52
4¼ x 3¾ x ¾	3.93	3.15	2.62	2.26	1.97	1.75	1.57	1.43	1.31	1.21

For angles of intermediate thicknesses the safe loads can be assumed as approximately proportional to their areas or weights.

PENCOYD UNEVEN ANGLES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Long Leg Vertical.

Fibre Stress 16,000 lbs. per Square Inch.

Size of Angle. Inches.	*Length of Span in Feet.*							
	1	2	3	4	5	6	7	8
	Safe Load in Net Tons.							
4 x 3 x $\frac{5}{16}$	6.56	3.28	2.19	1.64	1.31	1.09	0.94	0.82
$4\frac{1}{8}$ x $3\frac{1}{8}$ x $\frac{5}{8}$	12.43	6.22	4.14	3.11	2.49	2.07	1.78	1.55
$3\frac{1}{2}$ x 3 x $\frac{5}{16}$	5.07	2.54	1.69	1.27	1.01	0.85	0.72	0.63
$3\frac{13}{16}$ x $3\frac{5}{16}$ x $\frac{5}{8}$	10.67	5.34	3.56	2.67	2.13	1.78	1.52	1.33
$3\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{1}{4}$	4.05	2.03	1.35	1.01	0.81	0.68	0.58	0.51
$3\frac{3}{4}$ x $2\frac{3}{4}$ x $\frac{1}{2}$	8.43	4.22	2.81	2.11	1.69	1.41	1.20	1.05
$3\frac{1}{2}$ x 2 x $\frac{1}{4}$	3.84	1.92	1.28	0.96	0.77	0.64	0.56	0.48
$3\frac{5}{8}$ x $2\frac{1}{8}$ x $\frac{3}{8}$	5.81	2.91	1.94	1.45	1.16	0.97	0.83	0.73
3 x $2\frac{1}{2}$ x $\frac{1}{4}$	2.93	1.47	0.98	0.73	0.59	0.49	0.42	0.37
$3\frac{1}{4}$ x $2\frac{3}{4}$ x $\frac{1}{2}$	6.40	3.20	2.13	1.60	1.28	1.07	0.91	0.80
3 x 2 x $\frac{1}{4}$	2.88	1.44	0.96	0.72	0.58	0.48	0.41	0.36
$3\frac{1}{4}$ x $2\frac{1}{4}$ x $\frac{1}{2}$	6.08	3.04	2.03	1.52	1.22	1.01	0.87	0.76
$2\frac{1}{2}$ x 2 x $\frac{3}{16}$	1.55	0.78	0.52	0.39	0.31	0.26	0.22	0.19
$2\frac{13}{16}$ x $2\frac{5}{16}$ x $\frac{1}{2}$	4.69	2.35	1.56	1.17	0.94	0.78	0.67	0.59
$2\frac{1}{4}$ x $1\frac{1}{2}$ x $\frac{3}{16}$	1.23	0.62	0.41	0.31	0.25	0.21	0.18	0.15
$2\frac{7}{16}$ x $1\frac{11}{16}$ x $\frac{3}{8}$	2.45	1.23	0.82	0.61	0.49	0.41	0.35	0.31
2 x $1\frac{1}{2}$ x $\frac{3}{16}$	0.96	0.48	0.32	0.24	0.19	0.16	0.14	0.12
$2\frac{3}{16}$ x $1\frac{11}{16}$ x $\frac{3}{8}$	1.92	0.96	0.64	0.48	0.38	0.32	0.27	0.24
2 x $1\frac{1}{4}$ x $\frac{3}{16}$	0.96	0.48	0.32	0.24	0.19	0.16	0.14	0.12
$2\frac{3}{16}$ x $1\frac{7}{16}$ x $\frac{3}{8}$	1.92	0.96	0.64	0.48	0.38	0.32	0.27	0.24

For angles of intermediate thicknesses the safe loads can be assumed as approximately proportional to their areas or weights.

PENCOYD UNEVEN ANGLES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Short Leg Vertical.

Fibre Stress 16,000 lbs. per Square Inch.

Size of Angle. Inches.	*Length of Span in Feet.*									
	4	5	6	7	8	9	10	11	12	13
	Safe Load in Net Tons.									
8 x 6 x $\frac{1}{2}$	6.40	5.12	4.27	3.66	3.20	2.84	2.56	2.33	2.13	1.97
$8\frac{1}{4}$ x $6\frac{1}{4}$ x 1	12.27	9.81	8.18	7.01	6.13	5.46	4.91	4.46	4.09	3.78
7 x $3\frac{1}{2}$ x $\frac{1}{2}$	2.15	1.72	1.43	1.23	1.07	0.95	0.86	0.78	0.72	0.66
$7\frac{1}{4}$ x $3\frac{3}{4}$ x 1	4.13	3.31	2.76	2.36	2.07	1.84	1.65	1.50	1.38	1.27
$6\frac{1}{2}$ x 4 x $\frac{3}{8}$	2.16	1.73	1.44	1.23	1.08	0.96	0.86	0.78	0.72	0.66
$6\frac{7}{8}$ x $4\frac{3}{8}$ x $\frac{15}{16}$	5.43	4.34	3.62	3.10	2.71	2.41	2.17	1.97	1.81	1.67
6 x 4 x $\frac{3}{8}$	2.13	1.71	1.42	1.22	1.07	0.95	0.85	0.78	0.71	0.66
$6\frac{3}{8}$ x $4\frac{3}{8}$ x $\frac{15}{16}$	5.31	4.25	3.54	3.03	2.65	2.36	2.12	1.93	1.77	1.63
6 x $3\frac{1}{2}$ x $\frac{3}{8}$	1.64	1.31	1.09	0.94	0.82	0.73	0.66	0.60	0.55	0.50
$6\frac{3}{8}$ x $3\frac{7}{8}$ x $\frac{15}{16}$	3.69	2.95	2.47	2.11	1.85	1.64	1.48	1.34	1.23	1.14
$5\frac{1}{2}$ x $3\frac{1}{2}$ x $\frac{3}{8}$	1.63	1.30	1.09	0.93	0.81	0.72	0.65	0.59	0.54	0.50
$5\frac{3}{4}$ x $3\frac{3}{4}$ x $\frac{5}{8}$	2.80	2.24	1.87	1.60	1.40	1.24	1.12	1.02	0.93	0.86
5 x 4 x $\frac{3}{8}$	2.09	1.67	1.40	1.20	1.05	0.93	0.84	0.76	0.70	0.64
$5\frac{3}{16}$ x $4\frac{3}{16}$ x $\frac{3}{4}$	3.91	3.13	2.61	2.23	1.95	1.74	1.56	1.42	1.30	1.20
5 x $3\frac{1}{2}$ x $\frac{5}{16}$	1.36	1.09	0.91	0.78	0.68	0.60	0.54	0.49	0.45	0.42
$5\frac{1}{4}$ x $3\frac{3}{4}$ x $\frac{3}{4}$	3.17	2.54	2.12	1.81	1.59	1.41	1.27	1.15	1.06	0.98
5 x 3 x $\frac{5}{16}$	1.00	0.80	0.67	0.57	0.50	0.44	0.40	0.36	0.33	0.31
$5\frac{1}{4}$ x $3\frac{1}{4}$ x $\frac{3}{4}$	2.37	1.90	1.58	1.36	1.19	1.05	0.95	0.86	0.79	0.73
$4\frac{1}{2}$ x 3 x $\frac{5}{16}$	1.00	0.80	0.67	0.57	0.50	0.44	0.40	0.36	0.34	0.31
$4\frac{3}{4}$ x $3\frac{1}{4}$ x $\frac{3}{4}$	2.35	1.88	1.57	1.34	1.17	1.04	0.94	0.85	0.78	0.72
4 x $3\frac{1}{2}$ x $\frac{5}{16}$	1.33	1.07	0.89	0.76	0.67	0.59	0.53	0.48	0.44	0.41
$4\frac{1}{4}$ x $3\frac{3}{4}$ x $\frac{3}{4}$	3.11	2.49	2.07	1.78	1.55	1.38	1.24	1.13	1.04	0.96

For angles of intermediate thicknesses the safe loads can be assumed as approximately proportional to their areas or weights.

PENCOYD UNEVEN ANGLES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Short Leg Vertical.

Fibre Stress 16,000 lbs. per Square Inch.

Size of Angle. Inches.	*Length of Span in Feet.*							
	1	2	3	4	5	6	7	8
	Safe Load in Net Tons.							
4 x 3 x $\frac{5}{16}$	3.89	1.95	1.30	0.97	0.78	0.65	0.56	0.49
$4\frac{1}{8}$ x $3\frac{1}{8}$ x $\frac{5}{8}$	6.19	3.10	2.06	1.55	1.24	1.03	0.88	0.77
$3\frac{1}{2}$ x 3 x $\frac{5}{16}$	3.89	1.95	1.30	0.97	0.78	0.65	0.56	0.49
$3\frac{13}{16}$ x $3\frac{5}{16}$ x $\frac{5}{8}$	8.16	4.08	2.72	2.04	1.63	1.36	1.17	1.02
$3\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{1}{4}$	2.19	1.10	0.73	0.55	0.44	0.37	0.31	0.27
$3\frac{3}{4}$ x $2\frac{3}{4}$ x $\frac{1}{2}$	4.69	2.35	1.56	1.17	0.94	0.78	0.67	0.59
$3\frac{1}{2}$ x 2 x $\frac{1}{4}$	1.44	0.72	0.48	0.36	0.29	0.24	0.21	0.18
$3\frac{5}{8}$ x $2\frac{1}{8}$ x $\frac{3}{8}$	2.19	1.10	0.73	0.55	0.44	0.37	0.31	0.27
3 x $2\frac{1}{2}$ x $\frac{1}{4}$	2.13	1.07	0.71	0.53	0.43	0.36	0.30	0.27
$3\frac{1}{4}$ x $2\frac{3}{4}$ x $\frac{1}{2}$	4.69	2.35	1.56	1.17	0.94	0.78	0.67	0.59
3 x 2 x $\frac{1}{4}$	1.39	0.70	0.46	0.35	0.28	0.23	0.20	0.17
$3\frac{1}{4}$ x $2\frac{1}{4}$ x $\frac{1}{2}$	3.04	1.52	1.01	0.76	0.61	0.51	0.43	0.38
$2\frac{1}{2}$ x 2 x $\frac{3}{16}$	1.01	0.51	0.34	0.25	0.20	0.17	0.14	0.13
$2\frac{13}{16}$ x $2\frac{5}{16}$ x $\frac{1}{2}$	3.20	1.60	1.07	0.80	0.64	0.53	0.46	0.40
$2\frac{1}{4}$ x $1\frac{1}{2}$ x $\frac{3}{16}$	0.59	0.30	0.20	0.15	0.12	0.10	0.08	0.07
$2\frac{7}{16}$ x $1\frac{11}{16}$ x $\frac{3}{8}$	1.28	0.64	0.43	0.32	0.26	0.21	0.18	0.16
2 x $1\frac{1}{2}$ x $\frac{3}{16}$	0.59	0.30	0.20	0.15	0.12	0.10	0.08	0.07
$2\frac{3}{16}$ x $1\frac{11}{16}$ x $\frac{3}{8}$	1.28	0.64	0.43	0.32	0.26	0.21	0.18	0.16
2 x $1\frac{1}{4}$ x $\frac{3}{16}$	0.37	0.19	0.12	0.09	0.07	0.06	0.05	0.05
$2\frac{3}{16}$ x $1\frac{7}{16}$ x $\frac{3}{8}$	0.91	0.46	0.30	0.23	0.18	0.15	0.13	0.11

For angles of intermediate thicknesses the safe loads can be assumed as approximately proportional to their areas or weights.

PENCOYD Z BARS.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Fibre Stress 16,000 lbs. per Square Inch.

Sec. No.	*Size in Ins.*	*Thickness of Metal.*	*Length of Span in Feet.* 4	5	6	8	10	12	14	16	18
			Safe Load in Net Tons.								
60Z	6	3/8	11.25	9.00	7.50	5.63	4.50	3.75	3.21	2.81	2.50
61Z	6 1/16	7/16	13.11	10.48	8.74	6.55	5.24	4.37	3.74	3.28	2.91
62Z	6 1/8	1/2	14.96	11.97	9.97	7.48	5.98	4.99	4.27	3.74	3.32
63Z	6	9/16	15.39	12.32	10.26	7.70	6.16	5.13	4.40	3.85	3.42
64Z	6 1/16	5/8	17.09	13.67	11.39	8.55	6.84	5.70	4.88	4.27	3.80
65Z	6 1/8	11/16	18.80	15.04	12.53	9.40	7.52	6.27	5.37	4.70	4.18
66Z	6	3/4	18.72	14.98	12.48	9.36	7.49	6.24	5.35	4.68	4.16
67Z	6 1/16	13/16	20.29	16.23	13.53	10.14	8.12	6.76	5.80	5.07	4.51
68Z	6 1/8	7/8	21.86	17.49	14.58	10.93	8.75	7.29	6.25	5.47	4.86
50Z	5	5/16	7.01	5.61	4.67	3.50	2.80	2.33	2.00	1.75	1.56
51Z	5 1/16	3/8	8.39	6.71	5.59	4.19	3.36	2.80	2.40	2.10	1.86
52Z	5 1/8	7/16	9.76	7.81	6.51	4.88	3.90	3.25	2.79	2.44	2.17
53Z	5	1/2	10.15	8.12	6.77	5.07	4.06	3.38	2.90	2.54	2.26
54Z	5 1/16	9/16	11.40	9.12	7.61	5.70	4.56	3.80	3.26	2.85	2.53
55Z	5 1/8	5/8	12.66	10.13	8.44	6.33	5.06	4.22	3.62	3.16	2.81
56Z	5	11/16	12.63	10.10	8.42	6.31	5.05	4.21	3.61	3.15	2.81
57Z	5 1/16	3/4	13.78	11.02	9.19	6.89	5.51	4.59	3.94	3.44	3.06
40Z	4	1/4	3.97	3.17	2.64	1.98	1.59	1.32	1.13	0.99	0.88
41Z	4 1/16	5/16	4.93	3.95	3.29	2.47	1.97	1.64	1.41	1.23	1.10
42Z	4 1/8	3/8	5.91	4.73	3.94	2.95	2.36	1.97	1.69	1.48	1.31
43Z	4	7/16	6.27	5.01	4.18	3.13	2.51	2.09	1.79	1.57	1.39
44Z	4 1/16	1/2	7.17	5.73	4.78	3.58	2.87	2.39	2.05	1.79	1.59
45Z	4 1/8	9/16	8.01	6.41	5.34	4.01	3.21	2.67	2.29	2.00	1.78
46Z	4	5/8	8.07	6.46	5.38	4.04	3.23	2.69	2.31	2.02	1.79
47Z	4 1/16	11/16	8.87	7.10	5.92	4.44	3.55	2.96	2.53	2.22	1.97
48Z	4 1/8	3/4	9.68	7.74	6.45	4.84	3.87	3.22	2.76	2.42	2.15
30Z	3	1/4	2.50	2.00	1.66	1.25	1.00	0.83	0.71	0.62	0.56
31Z	3 1/16	5/16	3.06	2.45	2.04	1.53	1.23	1.02	0.87	0.77	0.68
32Z	3 1/8	3/8	3.70	2.96	2.47	1.85	1.48	1.23	1.06	0.93	0.82
33Z	3	7/16	3.73	2.99	2.49	1.87	1.49	1.24	1.07	0.93	0.82
34Z	3 1/32	15/32	3.99	3.20	2.66	2.00	1.60	1.33	1.14	1.00	0.89
35Z	3 1/16	1/2	4.25	3.40	2.83	2.12	1.70	1.42	1.21	1.06	0.94

PENCOYD DECK BEAMS.

Greatest safe distributed load in net tons for least section.
For increased sections use coefficient of fifth column.
For centre loads take one-half of tabular load.

Figures in fine type under loads denote corresponding deflections in inches. For half the load in centre this deflection will be reduced one-fifth. For spans below black line the deflection is excessive.

Section No.	Size in Ins.	Weight in Pounds per Foot	Coefficient for Safe Load Distributed.	Add to Coefficient for each Increase of a Pound per Foot.	Length of Span in Feet. Safe Load in Net Tons. 6	8	10	12	14	16	18	20	22	24	26	28	30	Size in Ins.
110D	$11\frac{1}{2}$	32.2	148.74	3.22	24.33 .05	18.59 .09	14.87 .13	12.40 .19	10.62 .26	9.30 .34	8.26 .43	7.44 .53	6.76 .65	6.20 .77	5.72 .90	5.31 1.05	4.96 1.20	$11\frac{1}{2}$
100D	10	28.0	110.54	2.86	18.42 .05	13.82 .10	11.05 .15	9.21 .22	7.90 .29	6.91 .38	6.14 .49	5.53 .60	5.02 .73	4.61 .86	4.25 1.01	3.95 1.17	3.68 1.35	10
90D	9	25.0	88.88	2.55	14.81 .06	11.11 .11	8.89 .17	7.41 .24	6.35 .33	5.56 .43	4 94 .54	4.44 .67	4.04 .81	3.70 .97	3.41 1.14	3.17 1.31	2.96 1.51	9
80D	8	21.0	68.14	2.28	11.36 .07	8.52 .12	6.81 .19	5.68 .27	4.87 .37	4.26 .49	3.79 .61	3.41 .76	3.10 .92	2.84 1.09	2.62 1.28	2.43 1.49	2.27 1.71	8
70D	7	18.0	49.82	2.02	8.30 .08	6 23 .14	4.98 .22	4.15 .31	3.56 .42	3.11 .55	2.77 .70	2.49 .87	2.26 1.05	2.08 1.25	1.92 1.46	1.78 1.70	1.66 1.95	7
60D	6	14.5	34.34	1.69	5.72 .09	4.29 .16	3.43 .25	2.86 .36	2.45 .50	2.15 .65	1.91 .82	1.72 1.01	1.56 1.22	1.43 1.46	1.32 1.71	1.23 1.98	1.14 2.28	6
50D	5	11.5	22.94	1.39	3.82 .11	2.87 .20	2.29 .31	1.91 .44	1.64 .60	1.43 .80	1.27 1.00	1.15 1.23	1.04 1.49	0.96 1.78	0.88 2.08	0.82 2.42	0.76 2.77	5

PENCOYD TEES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Fibre Stress 16,000 lbs. per Square Inch.

Sec. No.	*Size Flange by Stem. Inches.*	*Wt. per Foot in Lbs.*	*Length of Span in Feet.*									
			4	5	6	7	8	9	10	11	12	13
			Safe Load in Net Tons.									
64T	6 x 4	17.4	2.92	2.34	1.95	1.67	1.46	1.30	1.17	1.06	0.97	0.90
65T	6 x $5\frac{1}{4}$	39.0	10.92	8.74	7.28	6.24	5.46	4.85	4.37	3.97	3.64	3.36
53T	5 x $3\frac{1}{2}$	17.0	2.89	2.31	1.93	1.65	1.45	1.28	1.16	1.05	0.96	0.89
54T	5 x 4	15.3	2.81	2.25	1.87	1.61	1.41	1.25	1.12	1.02	0.94	0.86
42T	4 x 2	6.5	0.45	0.36	0.30	0.26	0.23	0.20	0.18	0.16	0.15	0.14
43T	4 x 3	9.0	1.20	0.96	0.80	0.68	0.60	0.53	0.48	0.44	0.40	0.37
44T	4 x 3	10.2	1.36	1.09	0.91	0.78	0.68	0.60	0.54	0.49	0.45	0.42
440T	4 x 4	10.9	2.19	1.75	1.46	1.25	1.09	0.97	0.87	0.79	0.73	0.67
441T	4 x 4	13.7	2.69	2.15	1.79	1.53	1.34	1.19	1.07	0.98	0.89	0.83
45T	4 x $4\frac{1}{2}$	13.5	3.11	2.49	2.07	1.77	1.55	1.38	1.24	1.13	1.03	0.96
38T	$3\frac{1}{2}$ x 3	7.0	1.00	0.80	0.67	0.57	0.50	0.44	0.40	0.36	0.33	0.31
39T	$3\frac{1}{2}$ x 3	8.5	1.17	0.94	0.78	0.67	0.59	0.52	0.47	0.43	0.39	0.36
335T	$3\frac{1}{2}$ x $3\frac{1}{2}$	7.0	1.19	0.95	0.79	0.68	0.59	0.53	0.47	0.43	0.39	0.36
336T	$3\frac{1}{2}$ x $3\frac{1}{2}$	9.0	1.54	1.24	1.03	0.88	0.77	0.69	0.62	0.56	0.51	0.47
337T	$3\frac{1}{2}$ x $3\frac{1}{2}$	11.0	1.99	1.59	1.32	1.13	0.99	0.88	0.79	0.72	0.66	0.61
30T	3 x $1\frac{1}{2}$	4.0	0.21	0.17	0.14	0.12	0.11	0.09	0.08	0.08	0.07	0.06
31T	3 x $2\frac{1}{2}$	5.0	0.56	0.45	0.37	0.32	0.28	0.25	0.22	0.20	0.19	0.17
32T	3 x $2\frac{1}{2}$	6.0	0.68	0.54	0.45	0.39	0.34	0.30	0.27	0.25	0.23	0.21
33T	3 x $2\frac{1}{2}$	7.0	0.80	0.64	0.53	0.46	0.40	0.35	0.32	0.29	0.27	0.25
34T	3 x $2\frac{1}{2}$	8.0	1.04	0.83	0.69	0.59	0.52	0.46	0.42	0.38	0.35	0.32
330T	3 x 3	6.5	0.99	0.79	0.66	0.56	0.49	0.44	0.39	0.36	0.33	0.30
331T	3 x 3	7.7	1.15	0.92	0.76	0.65	0.57	0.51	0.46	0.42	0.38	0.35
35T	3 x $3\frac{1}{2}$	8.3	1.56	1.25	1.04	0.89	0.78	0.69	0.62	0.57	0.52	0.48
36T	3 x $3\frac{1}{2}$	9.5	1.77	1.42	1.18	1.01	0.89	0.79	0.71	0.64	0.59	0.54

PENCOYD TEES.

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Fibre Stress 16,000 lbs. per Sq. In.

Section No.	*Size Flange by Stem. Inches.*	*Wt. per Foot in Lbs.*	*Length of Span in Feet.*							
			1	2	3	4	5	6	7	8
			Safe Load in Net Tons.							
28T	$2\frac{3}{4} \times 1\frac{3}{4}$	6.6	2.67	1.33	0.89	0.67	0.53	0.44	0.38	0.33
29T	$2\frac{3}{4} \times 2$	7.2	3.52	1.76	1.17	0.88	0.70	0.59	0.50	0.44
25T	$2\frac{1}{2} \times 1\frac{1}{4}$	3.3	0.59	0.29	0.20	0.15	0.12	0.10	0.08	0.07
225T	$2\frac{1}{2} \times 2\frac{1}{2}$	5.0	2.35	1.17	0.78	0.59	0.47	0.39	0.33	0.29
226T	$2\frac{1}{2} \times 2\frac{1}{2}$	5.8	2.93	1.46	0.98	0.73	0.59	0.49	0.42	0.37
227T	$2\frac{1}{2} \times 2\frac{1}{2}$	6.6	3.36	1.68	1.12	0.84	0.67	0.56	0.48	0.42
26T	$2\frac{1}{2} \times 2\frac{3}{4}$	5.7	3.20	1.60	1.07	0.80	0.64	0.53	0.46	0.40
27T	$2\frac{1}{2} \times 3$	6.0	3.79	1.89	1.26	0.94	0.76	0.63	0.54	0.47
24T	$2\frac{1}{4} \times \frac{9}{16}$	2.2	0.16	0.08	0.05	0.04	0.03	0.03	0.02	0.02
222T	$2\frac{1}{4} \times 2\frac{1}{4}$	4.0	1.65	0.82	0.55	0.41	0.33	0.27	0.23	0.21
223T	$2\frac{1}{4} \times 2\frac{1}{4}$	4.0	1.76	0.88	0.59	0.44	0.35	0.29	0.25	0.22
20T	$2 \times \frac{9}{16}$	2.0	0.16	0.08	0.05	0.04	0.03	0.03	0.02	0.02
21T	2×1	2.5	0.37	0.18	0.12	0.09	0.07	0.06	0.05	0.05
22T	$2 \times 1\frac{1}{16}$	2.0	0.27	0.13	0.09	0.07	0.05	0.04	0.04	0.03
23T	$2 \times 1\frac{1}{2}$	3.0	0.80	0.40	0.27	0.20	0.16	0.13	0.11	0.10
220T	2×2	3.5	1.39	0.69	0.46	0.35	0.28	0.23	0.20	0.17
17T	$1\frac{3}{4} \times 1\frac{1}{16}$	1.9	0.32	0.16	0.11	0.08	0.06	0.05	0.05	0.04
18T	$1\frac{3}{4} \times 1\frac{1}{4}$	3.5	0.75	0.37	0.25	0.19	0.15	0.12	0.11	0.09
117T	$1\frac{3}{4} \times 1\frac{3}{4}$	2.4	0.80	0.40	0.27	0.20	0.16	0.13	0.11	0.10
15T	$1\frac{1}{2} \times \frac{15}{16}$	1.4	0.16	0.08	0.05	0.04	0.03	0.03	0.02	0.02
115T	$1\frac{1}{2} \times 1\frac{1}{2}$	2.0	0.64	0.32	0.21	0.16	0.13	0.11	0.09	0.08
12T	$1\frac{1}{4} \times \frac{15}{16}$	1.2	0.16	0.08	0.05	0.04	0.03	0.03	0.02	0.02
112T	$1\frac{1}{4} \times 1\frac{1}{4}$	1.5	0.48	0.24	0.16	0.12	0.10	0.08	0.07	0.06
110T	1×1	1.0	0.27	0.13	0.09	0.07	0.05	0.04	0.04	0.03

SUPPORTS AND CONNECTIONS FOR BEAMS AND GIRDERS.

When the span becomes too great, or the loads excessive for rolled beams, refer to the tables on pages 127 to 137 for the strength of riveted girders of the several sections described.

When the support of the beam or girder is formed on masonry, a bearing plate should be provided for the ends of the beams to distribute the pressure over a sufficient area. The permissible pressure per unit of area varies widely according to the building laws of the locality. The figures given are the mean of the various extremes. Ordinary brick, lime mortar, 5 tons per square foot; hard brick, cement mortar, 10 tons per square foot; rubble masonry in cement, or cement concrete not less than one month old, 10 tons per square foot; first-class masonry, parallel layers, natural bed, sandstone, 18 tons per square foot; limestone, 20 tons per square foot; granite, 30 tons per square foot. The following table has been calculated with these permissible loads.

Depth of Beam or Channel. Inches.	*Bearing on Wall. Inches.*	*Plates.*		*Safe Bearing Values in Net Tons. Plates on*		
		Size in Inches.	*Thickness in Inches.*	*Common Brick Work, Lime Mortar.*	*First-class Brick Work or Cement Concrete.*	*First-class Masonry.*
*24, 20, 18	16	16 x 16	1	8.9	17.8	35.6
15	12	12 x 16	¾	6.7	13.3	26.7
12	12	12 x 12	¾	5.0	10.0	20.0
10 and 9	10	10 x 10	⅝	3.5	6.9	13.9
8 and 7	8	8 x 10	⅝	2.8	5.6	11.1
6 and 5	6	6 x 6	⅝	1.3	2.5	5.0
4 and 3	6	6 x 6	½	1.3	2.5	5.0

*For short spans of 24″ and 20″ I beams special plates must be calculated.

When two or more beams are used together, they should be tied at intervals with fitted separators between them as described on page 257. These separators should be spaced near the supports, and at intervals of 5 or 6 feet.

The standard angle connections for framing "I" beams are described on pages 254 to 260. These connections have been designed to provide for beams of the sizes and length of spans given in the table on page 260. If the beams are much shorter, and the total load supported greater than described, it may become necessary to design special connections, to provide for the increased end shear.

APPROXIMATE FORMULÆ FOR ROLLED BEAMS.

The following rules for the strength and stiffness of rolled beams of various sections are intended for convenient application in cases where strict accuracy is not required.

The rules for rectangular and circular sections are correct, while those for the flanged sections are approximate and limited in their application to the standard shapes as given in our tables. They will be found to give results which have been proved by experiment to be sufficiently accurate for practical purposes. When the section of any beam is increased above the standard minimum dimensions, the flanges remaining unaltered, and the web alone being thickened, the tendency will be for the load as found by the rules to be in excess of the actual, but within the limits that it is possible to vary any section in the rolling, the rules will apply without any serious inaccuracy.

The loads are the same as in the beam tables, producing a fibre stress of 16,000 lbs. per square inch, on the assumption that the steel referred to has a tenacity about 20 per cent. in excess of iron. These loads will be approximately one-half of loads that would injure the elasticity of the material.

The rules for deflection apply to any load below the elastic limit, or less than double the greatest safe load by the rules.

If the beams are long without lateral support, reduce the loads for the ratios of width to span, as described on page 23.

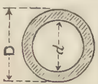
Example.—A 12-inch No. 120 B **I** beam, area 9.27 square inches, 15 feet span, by the tables, will support a distributed load of 13 tons, and by the approximate rule $\frac{3390 \times 9.27 \times 12}{15} = 25{,}140$ pounds.

The deflection by the rule will also be found nearly as in the tables.

APPROX. GREATEST SAFE LOADS IN LBS. ON IRON OR STEEL BEAMS.

Based on fibre strains of 14,000 lbs. for iron and 16,000 lbs. for steel.

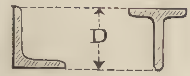
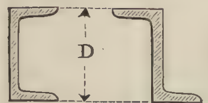
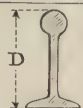
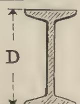
L = Length in feet between supports. A = Sectional area of beam in square inches. D = Depth of beam in inches.
a = Interior area in square inches. d = Interior depth in inches. w = Working load in net tons.

I.	II.	III.	IV.	V.	VI.	VII.
	W = Greatest Safe Load in Pounds.				$\triangle$ = *Deflection in Inches.*	
Shape of Section.	*Load in Middle of Beam.*		*Load Distributed.*			
	Iron.	*Steel.*	*Iron.*	*Steel.*	*Load in Middle.*	*Distributed Load.*
 *Solid Rectangle.*	$W=\frac{780AD}{L}$	$W=\frac{890AD}{L}$	$W=\frac{1560AD}{L}$	$W=\frac{1780AD}{L}$	$\triangle=\frac{wL^3}{32AD^2}$	$\triangle=\frac{wL^3}{52AD^2}$
 *Hollow Rectangle.*	$W=\frac{780(AD-ad)}{L}$	$W=\frac{890(AD-ad)}{L}$	$W=\frac{1560(AD-ad)}{L}$	$W=\frac{1780(AD-ad)}{L}$	$\triangle=\frac{wL^3}{32(AD^2-ad^2)}$	$\triangle=\frac{wL^3}{52(AD^2-ad^2)}$
 *Solid Cylinder.*	$W=\frac{580AD}{L}$	$W=\frac{667AD}{L}$	$W=\frac{1160AD}{L}$	$W=\frac{1333AD}{L}$	$\triangle=\frac{wL^3}{24AD^2}$	$\triangle=\frac{wL^3}{38AD^2}$
 *Hollow Cylinder.*	$W=\frac{580(AD-ad)}{L}$	$W=\frac{667(AD-ad)}{L}$	$W=\frac{1160(AD-ad)}{L}$	$W=\frac{1333(AD-ad)}{L}$	$\triangle=\frac{wL^3}{24(AD^2-ad^2)}$	$\triangle=\frac{wL^3}{38(AD^2-ad^2)}$

APPROX. GREATEST SAFE LOADS IN LBS. ON IRON OR STEEL BEAMS.

Based on fibre strains of 14,000 lbs. for iron and 16,000 lbs. for steel.

L = Length in feet between supports. A = Sectional area of beam in square inches. D = Depth of beam in inches.
a = Interior area in square inches. d = Interior depth in inches. w = Working load in net tons.

I.		II.	III.	IV.	V.	VI.	VII.
Shape of Section.		W = *Greatest Safe Load in Pounds.*				$\triangle$ = *Deflection in Inches.*	
		Load in Middle of Beam.		*Load Distributed.*		*Load in Middle.*	*Distributed Load.*
		Iron.	*Steel.*	*Iron.*	*Steel.*		
	*Even-legged Angle or Tee.*	$W=\frac{770AD}{L}$	$W=\frac{885AD}{L}$	$W=\frac{1540AD}{L}$	$W=\frac{1770AD}{L}$	$\triangle=\frac{wL^3}{32AD^2}$	$\triangle=\frac{wL^3}{52AD^2}$
	*Channel or* **Z** *Bars.*	$W=\frac{1335AD}{L}$	$W=\frac{1525AD}{L}$	$W=\frac{2670AD}{L}$	$W=\frac{3050AD}{L}$	$\triangle=\frac{wL^3}{53AD^2}$	$\triangle=\frac{wL^3}{85AD^2}$
	*Deck Beam.*	$W=\frac{1200AD}{L}$	$W=\frac{1380AD}{L}$	$W=\frac{2400AD}{L}$	$W=\frac{2760AD}{L}$	$\triangle=\frac{wL^3}{50AD^2}$	$\triangle=\frac{wL^3}{80AD^2}$
	**I** *Beam.*	$W=\frac{1485AD}{L}$	$W=\frac{1695AD}{L}$	$W=\frac{2970AD}{L}$	$W=\frac{3390AD}{L}$	$\triangle=\frac{wL^3}{58AL^2}$	$\triangle=\frac{wL^3}{93AD^2}$

The preceding rules apply to beams supported at each end. For beams supported otherwise alter the coefficients of the table as described below, referring to the respective columns indicated by number.

CHANGES OF COEFFICIENTS FOR SPECIAL FORMS OF BEAMS.

Kind of Beam.	*Coefficient for Safe Load.*	*Coefficient for Deflection.*
Fixed at one end, loaded at the other.	One-fourth ($\frac{1}{4}$) of the coefficient of col. II or III.	One-sixteenth ($\frac{1}{16}$) of the coefficient of col. VI.
Fixed at one end, load evenly distributed.	One-fourth ($\frac{1}{4}$) of the coefficient of col. IV or V.	Five-forty-eighths ($\frac{5}{48}$) of the coefficient of col. VII.
Both ends rigidly fixed, or a continuous beam, with a load in middle.	Twice the coefficient of col. II or III.	Four times the coefficient of col. VI.
Both ends rigidly fixed, or a continuous beam with load evenly distributed.	One and one-half ($1\frac{1}{2}$) times the coefficient of col. IV or V.	Five times the coefficient of col. VII.

It will be observed that these rules apply only to the intermediate spans of continuous beams; when continuity does not occur at the ends, the conditions are altered. If, however, the outer ends of a continuous beam overhang the end-supports from one-fifth to one-fourth of a span, and bear the same proportion of load as the parts between supports, then the outer spans may be of same length as the intermediate spans, subject to the same load, and the strength and stiffness are determined by the same rules; otherwise the outer spans ought to be only four-fifths of the

length of the intermediate spans when the load is distributed, or three-fourths of the same when the load is concentrated in the middle; or, if the lengths of spans are all alike, the loads on outer spans ought to be reduced in the same proportion.

The following table exhibits the relative proportion of strength and stiffness existing between various classes of beams when they have the same lengths and uniform cross-section; the deflections being comparative figures for the same loads on any beam.

Kind of Beam.	*Maximum Load as*	*Deflection as*
Fixed at one end—loaded at the other . .	$\frac{1}{4}$	16
Fixed at one end—load evenly distributed	$\frac{1}{2}$	6
Supported at both ends—load in middle .	1	1
Supported at both ends—load evenly distributed	2	$\frac{5}{8}$
Continuous beam—load in middle . . .	2	$\frac{1}{4}$
Continuous beam—load evenly distributed	3	$\frac{1}{8}$

The load and deflection of a beam supported at both ends and loaded in the middle have been taken as the units for comparison. Beams of uniform length and section will be equally strained when loaded in the ratio described in the first column, or if the beams are loaded equally, within their elastic limits, the respective deflections will be in the ratio described in second column.

BEAMS FOR SUPPORTING IRREGULAR LOADS.

When a beam has its load unequally distributed, the proper size of the beam can be determined by finding the maximum bending moment and proportioning the beam accordingly. Equilibrium is obtained when the bending moment is equal to the moment of resistance. That is, when the external force multiplied by the leverage with which it acts is equal to the strength of the material in the cross-section of the beam multiplied by the leverage with which it acts.

The resistance of a beam is found by dividing the moment of inertia of the section by the distance from neutral axis to extreme fibres, and this value for any rolled section will be found in the tables, pages 188 to 211. This tabulated resistance, multiplied by the limiting fibre stress on the beam, is the measure of strength of the section.

RULE FOR BEAMS BEARING IRREGULAR LOADS.

Finding by the methods described on pages 220 to 226 the maximum bending moment on the beam, divide the bending moment by the limiting fibre stress, and select from the tables, pages 188 to 211 a beam whose resistance is not less than this quotient. The greatest safe fibre stress in our tables is 16,000 lbs. The stress should be modified for various considerations, as described on pages 22 and 23.

Example.—An **I** beam 8 feet long is to be fixed at one end and loaded at the other with 5,000 lbs. and carrying also an evenly distributed load of 8,000 lbs. What size of beam should be used so as not to be strained over 16,000 lbs.?

$$\text{Moment for end load} = 5{,}000 \times 96 = 480{,}000 \text{ inch-lbs.}$$

$$\text{" " distributed load} = \frac{8{,}000 \times 96}{2} = 384{,}000 \text{ " "}$$

$$\text{Total} = 864{,}000 \text{ " "}$$

Divide this bending moment by the fibre stress afore-

said, and select from column XI, page 189, beams whose resistances are nearest the quotients, as follows:

15 inch. No. 153 B. 55.0 pounds per foot.

In some instances the maximum bending moment can be most readily found by the use of diagrams, as described on pages 220 to 226. When this is done use any convenient scale, making all loads and all distances respectively of the same denominations. The maximum bending moment can then be measured to scale.

Example.—A beam 20 feet long between supports will carry three loads, which we will call A, B and C.
$A = 4{,}000$ lbs. and is 4 feet from one end of the beam.
$C = 6{,}000$ lbs. and is 3 feet from the other end of the beam.
$B = 5{,}000$ lbs. and is 5 feet from C and 8 feet from A.

Required a suitable beam, not strained over 12,000 lbs.

Describe a diagram as in Fig. 2, page 226, when the following bending moments will be obtained:

At point A.			At point B.			At point C.		
For load	A,	12,800	For load	B,	24,000	For load	C,	15,300
"	B,	8,000	"	A,	10,800	"	B,	9,000
"	C,	3,600	"	C,	6,400	"	A,	2,400
	Total,	24,400		Total,	41,200		Total,	26,700

The maximum moment at $B = 41{,}200$ foot-pounds or 494,400 inch-pounds. Dividing by 10,000 and 12,000, select from column XI, page 189, the following beams, whose resistances are nearest these quotients, and use the lighter beam.

15-inch beam, No. 150 B, 42.0 lbs. per foot.
12-inch " No. 122 B, 40.0 " " "

Note.—The tables of elements, except where otherwise specified, are calculated for dimensions in inches and weights in pounds, consequently in examples of above character it is necessary to obtain bending moments in inch-pounds.

BEAMS SUBJECTED TO COMPOUND STRESSES.

When the bending stresses on a beam are compounded by extraneous forces, producing additional stresses of tension, compression or torsion, then the longitudinal stresses resulting from bending stresses are modified in extent or direction.

No general rules can be given for such conditions, as every particular case requires its own proper determination. The following methods, though not strictly correct, will give safe practical results for ordinary cases.

WHEN THE BEAM IS SUBJECT TO EXTERNAL FORCES PRODUCING EITHER TENSION OR COMPRESSION, BUT IS SUPPORTED TO RESIST LATERAL FLEXURE.

Rule.—Find by methods previously described, the section of beam required to resist bending, then allowing from 10,000 to 16,000 pounds per square inch for the compression or tension according to the material or factor of safety used, add the two sectional areas together, which will give the section of beam required.

Example.—A beam having a clear span of 15 feet, bearing a uniform load of 500 pounds per lineal foot, is subjected to compression if it forms half a 30-foot truss as in Fig. 6, page 229, or to tension if forming a member in a roof chord in either case, say 18,000 pounds. Required a suitable beam strained about 12,000 pounds per square inch.

The total uniform load is $15 \times 500 = 7500$ pounds.

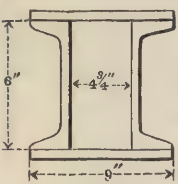
The bending moment due to same is $\frac{7500 \times 15 \times 12}{8} = 168{,}750$ inch-pounds. This divided by 12,000 gives a resistance of 14.1. From the tables, column XI, page 191, we find that the **I** beam having a resistance nearest to this 14.1 is an 8-inch **I** beam No. 80 B, area 5.29 square inches. Now the increase in area to be made for the tension or compression is $\frac{18000}{12000} = 1.5$ square inches, making the total area 6.79 square inches.

WHEN THE BEAM IS SUBJECT TO COMPRESSION AND IS LIABLE TO FAIL LIKE A HORIZONTAL STRUT BY LATERAL FLEXURE.

Rule.—Consider first the resistance as a strut and then make the necessary increment of section to resist the bending stress, remembering that if the addition is made to the flanges then only flange stresses have to be considered, but if the increased area is obtained by thickening the web of **I** beam or channel section, then the additional area so obtained should be treated as a rectangular section whose thickness is the amount added to the web, and whose depth is the depth of the beam.

Example.—A trussed girder of the form exhibited in Fig. 6, page 229, is a box section made up of two channels separated with flanges outward, and plated top and bottom. The whole girder is 30 feet long and is loaded 1,000 pounds per lineal foot. The compression resulting from the trussing is 25,000 pounds. The structure has no lateral bracing. What will be safe proportions for it, the stresses not to exceeed one-fifth of the ultimate, or 10,000 pounds per square inch ?

It is evident that we have to consider it as a flat-ended strut 30 feet long, liable to fail horizontally, and also as a series of three beams each 10 feet long and loaded with 10,000 pounds evenly distributed. Trying two light 6-inch channels, each 3.09 square inches section, separated $4\frac{3}{4}$ inches so as to be covered by 9-inch plates, we have (omitting the plates in this calculation) the radius of gyration around



vertical axis (see page 194) $= 2.29$ inches, $\frac{l}{r} = 157$, one-fifth of ultimate (by Table 3, page 162) $= 4,500$ pounds per square inch, or $4,500 \times 6.18 = 27,810$ pounds safe resistance, which is ample. Now proportioning the plates to resist the bending strain, we have maximum bending moments (see page 222), $\frac{120 \times 10,000}{8}$ $= 150,000$ inch-pounds.

The plates act with a leverage equal to the depth of the

channel, viz., 6 inches; $\frac{150{,}000}{6} = 25{,}000$ pounds tension on top or compression on bottom plate, which, allowing for 10,000 pounds per square inch, and allowing for loss by rivets, will require a plate $\frac{3}{8}$ inch thick.

Taking the last example, if it was desired to form the section from a pair of channels, latticed top and bottom, with no cover plates, we would have to consider the section added to the channels (being on the web alone) as a simple rectangular section.

Trying two 10-inch channels, separated $6\frac{1}{2}$ inches, flanges outward, and having least radius of gyration, for the pair = 3.90, $\frac{l}{r} = 92.3$. Safe load = 9,060 pounds per square inch. As the compression is 25,000 pounds, there are required 2.7 square inches for this purpose.

By the formula, page 112, $\frac{1{,}100 \times \text{area} \times 10}{10} = 10{,}000$, from which the area to resist bending is found to be 9.1 square inches.

Giving a total area for two channels of 11.8 square inches, or two 10-inch channels No. 101 *C*, weight 20 pounds per lineal foot will be required.

In cases where the load is concentrated at the truss points, there being no bending stress, the resistance as a strut has only to be considered, and when braced laterally the strut length is reduced to the distances between bracing.

Flexure and Tension.

When the tension forces are larger in comparison with the flexural forces, and where greater refinement is required, the resulting stresses on the beam can be closely approximated by the following formulæ.

$$S = \frac{M c}{I + \frac{a}{b} \frac{F l^2}{E}}$$

Here S = the extreme fibre stress as affected by the tension forces, M = bending moment, due to load, c = distance from neutral axis to extreme fibres, I = moment of inertia of sec-

tion of beam, $F =$ tension force, $l =$ length of beam, $E =$ modulus of elasticity of material of beam, a and b are constants depending on the method of supporting beam and nature of load. For a beam supported at the ends, and loaded at the middle, $\frac{b}{a} = 12$, while for the same beam uniformly loaded, $\frac{b}{a} = 9.6$. Having found S, add it to $\frac{F}{A}$ where $F =$ tension force and $A =$ area of beam section. Then $S + \frac{F}{A}$ gives the maximum fibre stress on the extreme fibres.

Example.—An eye-bar, 20 feet long, 8 inches deep, and 2 inches thick, is strained 10,000 pounds per square inch of section, and carries besides its weight a concentrated central load of 1,000 pounds. What is the extreme fibre stress? Bar weighs 1,100 pounds.

Bending moment, due to concentrated load	= 5,000	ft.-lbs.
" " " uniform "	= 2,750	"
	7,750	

$\frac{b}{a} = 10.8 \quad F = 160{,}000$ lbs. $\quad 7{,}750$ ft.-lbs. $= 93{,}000$ in.-lbs.

$$S = \frac{Mc}{I + \frac{a\,Fl^2}{b\,E}} = \frac{93{,}000 \times 4}{85.3 \times 1 \times \frac{160{,}000 \times 57{,}600}{10.8 \times 29{,}000{,}000}} = 3{,}243$$

$S + \frac{F}{A} = 3{,}243 + 10{,}000 = 13{,}243$ lbs. extreme fibre stress.

Compression and Flexure.

When the compressive forces are large as compared with the flexural forces, and the beam is confined laterally, so that it cannot fail in that direction as a strut, a close approximation to the extreme fibre stress is given by the following formulæ.

$$S = \frac{Mc}{I - \frac{a\,Fl^2}{b\,E}}$$

and the maximum unit stress is as before, $S + \frac{F}{A}$

For combined flexure and torsion, see page 234.

STRESSES ON BEAMS RESULTING FROM LOADS SUDDENLY APPLIED AND FROM PERCUSSION OR IMPACT.

When the force acting on a beam is rapidly applied the momentary resulting stresses are greater than the permanent static effect due to the same load without motion.

This live load effect will depend on the rapidity of its application, until extreme rapidity or instantaneous application occurs, when the momentary stresses become double in amount as compared with the static effect of the same load.

If this instantaneously applied load is accompanied with percussion or impact the resulting stresses depend on the energy of the body in motion. The following formulæ have been proposed to ascertain the fibre stress and deflection resulting from impactive forces:

$$D = d + \sqrt{2\,m\,h\,d + d^2}$$

$$T = S\left(1 + \sqrt{\frac{2\,m\,h}{d} + 1}\right)$$

$$m = \frac{35\,P}{35\,P + 17\,W}$$

$D =$ dynamic deflection due to fall of load P.
$d =$ static " " static load P.
$T =$ extreme fibre stress due to fall of load P.
$S =$ " " " " static load P.
$W =$ weight of beam.
$P =$ " " load.
$h =$ height of fall.

These formulæ apply to beams supported at both ends and the load falling on the middle of the beam.

The percussion due to the action of a swiftly moving body, will cause local concentrated stresses or distortion at the area of contact, the effects of which are not embraced in this consideration.

BEAMS OF ANGLE AND TEE SECTION.

It is frequently convenient to use angle or tee sections for roof purlines and similar purposes.

The length of span may be so great as compared to depth in these cases, that deflection instead of excessive fibre stress is the measure of utility.

An even-flanged angle or tee will deflect slightly less than an equally loaded rectangular section of the same depth and sectional area; but the extreme fibre stress of the former will be greater than in the rectangular section.

Therefore, for long beams, where deflection reaches the permissible limit before fibre stress becomes excessive, the rule for beams of angle and tee section given on page 113 will safely apply.

If, however, the fibre stress must be kept lower than this rule indicates, refer to the columns "resistance," pages 204 to 211, and apply as described on page 116.

Example.—A 4-inch $\times$ 4-inch tee, 3.98 square inches area, has a resistance of 2.02 (see column VII, page 204). Required its greatest safe load distributed over a beam of 10 feet span.

By the method on page 222 bending moment $= \frac{120\ W}{8} =$ $2.02 \times 16{,}000$ pounds, or $W = 2{,}155$ pounds nearly.

By the rule on page 113, column V, the safe load would be $\frac{1{,}770 \times 3.89 \times 4}{10} = 2{,}750$ pounds, and the deflection by column VII, page 113, would be $\frac{1.375 \times 1{,}000}{52 \times 3.98 \times 16} = .42$ inch, or only a little over $\frac{1}{360}$ of the span, while the extreme fibre stress at the outer edge of the stem would be about 17,000 pounds, or sufficiently below the elastic limit to justify its use for light purlines, etc.

RIVETED GIRDERS.

FOR TABLES,
SEE PAGES

FOR TABLES,
SEE PAGES

FOR TABLES,
SEE PAGES

RIVETED GIRDERS.

The tables, pages 127 to 137, represent a few of the sections of riveted girders most frequently used in structures. The single-webbed girders are the most economical in material, and most accessible for painting and inspection. But where great width and lateral stiffness are required, the double web or box girder is the best. If the length of the girder exceeds twenty times the width of the flange, the girder should either be given some lateral support, or else the section of the top flange should be increased. It is usual to allow flange strains of 15,000 lbs. per square inch of net section for steel girders for buildings. The safe loads for the girders in the accompanying tables are calculated on this assumption, the entire sectional area of the girder being considered.

The web of the girder should be made of such thickness that the vertical shearing strain will not exceed three-fourths of the horizontal strains, or 11,000 lbs. per square inch of section in the case of girders for buildings. The shearing strain is greatest at the supports, and is found by dividing half the load on the girder by the web section.

If the thickness of the web is less than $\frac{1}{60}$ of its depth, it should be stiffened to resist buckling, by the addition of vertical angles riveted to the web at invervals of not more than the depth of the girder. These stiffeners should always be used at the supports and at points where concentrated loading occurs.

The rivets should be from $\frac{3}{4}$ to $\frac{7}{8}$ inch in diameter, spaced not closer than three diameters, nor farther apart than sixteen times the thickness of plate connected.

It is good practice to limit the least depth of the girder to $\frac{1}{20}$ of the span, on account of deflection.

The following tables are calculated by the moments of inertia of the girder sections, for a fibre strain of 15,000 lbs. per square inch, and for a uniformly distributed load. Coefficient $= \frac{\text{Inertia} \times 10}{\text{extreme depth of girder}}$. The numbers in the

first columns of the tables correspond to those of the various sections of girders on the plates.

The tables give coefficients of strength, also weights per lineal foot, including stiffeners for each section, excepting girders without cover plates in first table, where stiffeners are omitted.

TO FIND THE SAFE DISTRIBUTED LOAD FOR ANY GIRDER.

Divide the coefficient of strength by the length of span in feet between centres of supports. The quotient will be the load in tons of 2,000 lbs.

TO FIND THE COEFFICIENT OF STRENGTH NECESSARY TO CARRY A CERTAIN LOAD ON A GIVEN SPAN.

Multiply the load in tons of 2,000 lbs. by the length of span in feet between centres of supports. If the load is concentrated at the centre of the girder, it must not exceed one-half the weight of the permissible uniformly distributed load.

If the load is concentrated at some point not in the middle of the girder, the safe load for any such position is to the safe central load as the square of $\frac{1}{2}$ the span is to the product of the segments of the span formed by the position of the load.

EXAMPLES FOR APPLICATION OF TABLES.

I. What is the carrying capacity of the single-web plate girder No. 16, with $\frac{3}{4}$-inch cover or flange plates, the girder being 20 feet long between centres of supports?

In the column of coefficients, and opposite the girder referred to, find proper coefficient for strength, which in this case is 2,678.

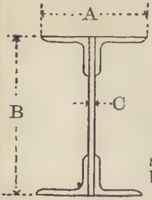
$$\text{Answer.}\quad \frac{2678}{20} = 134 \text{ tons equally distributed,}$$

or 67 tons in middle of girder.

II. A box girder is required 24 feet long between supports to carry a 20-inch brick wall weighing 66 tons. What is the requisite coefficient of strength?

$$\text{Answer.}\quad 66 \times 24 = 1584.$$

Referring to the table of box girders 16 inches wide, we find that girder No. 2, 18 inches deep, with a $\frac{5}{8}$-inch cover plate, has a coefficient of strength of 1587, or a little in excess of that required.



STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.

To find the distributed safe load in net tons, divide the coefficient in right-hand column by the length of span in feet.

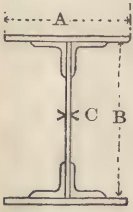
To find the coefficients of strength for a given load and span, multiply the uniformly distributed load in net tons by the span in feet between centres of supports.

Weights do not include stiffeners.

Depth. B.	*Web Thickness. C.*	*Flange Width. A.*	*Size of Angles.*	*Resistance.*	*Weight in Pounds per Lineal Foot.*	*Coefficient of Strength.*
18	$\frac{5}{16}$	$10\frac{5}{16}$	$5 \times 3\frac{1}{2} \times \frac{5}{16}$	92.9	57	464
18	$\frac{3}{8}$	$10\frac{3}{8}$	$5 \times 3\frac{1}{2} \times \frac{3}{8}$	110.0	67	550
18	$\frac{7}{16}$	$10\frac{7}{16}$	$5 \times 3\frac{1}{2} \times \frac{7}{16}$	126.9	77	634
18	$\frac{1}{2}$	$10\frac{1}{2}$	$5 \times 3\frac{1}{2} \times \frac{1}{2}$	143.7	88	718
20	$\frac{3}{8}$	$10\frac{3}{8}$	$5 \times 3\frac{1}{2} \times \frac{3}{8}$	126.8	69	634
20	$\frac{7}{16}$	$10\frac{7}{16}$	$5 \times 3\frac{1}{2} \times \frac{7}{16}$	146.4	80	731
20	$\frac{1}{2}$	$10\frac{1}{2}$	$5 \times 3\frac{1}{2} \times \frac{1}{2}$	165.8	91	829
22	$\frac{3}{8}$	$10\frac{3}{8}$	$5 \times 3\frac{1}{2} \times \frac{3}{8}$	144.1	72	720
22	$\frac{7}{16}$	$10\frac{7}{16}$	$5 \times 3\frac{1}{2} \times \frac{7}{16}$	166.5	83	832
22	$\frac{1}{2}$	$10\frac{1}{2}$	$5 \times 3\frac{1}{2} \times \frac{1}{2}$	188.7	94	943
24	$\frac{3}{8}$	$11\frac{3}{8}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	170.7	77	853
24	$\frac{7}{16}$	$11\frac{7}{16}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{7}{16}$	198.1	89	990
24	$\frac{1}{2}$	$11\frac{1}{2}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	225.4	102	1127
26	$\frac{3}{8}$	$11\frac{3}{8}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	189.7	80	948
26	$\frac{7}{16}$	$11\frac{7}{16}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{7}{16}$	220.4	92	1101
26	$\frac{1}{2}$	$11\frac{1}{2}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	250.9	105	1254
28	$\frac{3}{8}$	$12\frac{3}{8}$	$6 \times 3\frac{1}{2} \times \frac{3}{8}$	218.0	84	1090
28	$\frac{7}{16}$	$12\frac{7}{16}$	$6 \times 3\frac{1}{2} \times \frac{7}{16}$	255.5	98	1277
28	$\frac{1}{2}$	$12\frac{1}{2}$	$6 \times 3\frac{1}{2} \times \frac{1}{2}$	292.8	113	1464
30	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	256.3	92	1281
30	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	298.5	107	1492
30	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	340.4	122	1701
32	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	279.2	95	1396
32	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	325.1	110	1625
32	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	370.6	125	1853
34	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	302.5	97	1512
34	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	352.3	113	1761
34	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	401.8	129	2009
36	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	326.3	100	1631
36	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	380.1	116	1900
36	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	433.5	132	2167

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	THICKNESS OF COVER PLATES IN INCHES.																Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
			3/8		1/2		5/8		3/4		7/8		1		1 1/8		1 1/4				
			Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.			
1	18	12	940	105	1056	115	1296	125	1326	135	1455	145	1585	156	1715	166	1845	176	12	18	1
2	18	12			1307	138	1432	148	1558	159	1685	168	1812	179	1940	189	2067	199	12	18	2
3	18	12					1525	171	1648	181	1775	191	1900	201	2026	212	2151	222	12	18	3
4	21	12	1122	110	1282	120	1432	130	1583	140	1735	150	1886	161	2037	171	2188	181	12	21	4
5	21	12			1482	145	1630	156	1530	166	1928	176	2078	186	2228	196	2378	207	12	21	5
6	21	12					1846	179	1992	189	2133	199	2286	210	2435	220	2585	230	12	21	6
7	24	12	1330	114	1502	124	1675	134	1848	144	2022	155	2196	165	2358	175	2532	185	12	24	7
8	24	12			1745	153	1915	163	2086	173	2256	183	2427	193	2598	204	2770	214	12	24	8
9	24	12					2178	188	2348	198	2515	209	2683	219	2853	229	3021	239	12	24	9
10	27	12	1535	120	1730	130	1925	140	2120	150	2313	161	2508	171	2703	181	2898	191	12	27	10
11	27	12			2015	158	2207	168	2400	178	2591	188	2786	198	2980	209	3175	219	12	27	11
12	27	12					2522	197	2712	208	2902	218	3092	228	3283	238	3222	248	12	27	12
13	30	12	1746	125	1962	135	2180	145	2396	156	2612	166	2828	176	3045	186	3261	196	12	30	13
14	30	12			2293	166	2507	176	2725	186	2937	196	3152	207	3367	217	3582	227	12	30	14
15	30	12					2876	205	3087	215	3288	225	3511	235	3725	245	3937	256	12	30	15
16	33	12	1962	129	2200	139	2440	149	2678	160	2918	170	3158	180	3398	190	3638	200	12	33	16
17	33	12			2580	172	2816	182	3052	192	3288	202	3526	213	3763	223	4000	233	12	33	17
18	33	12					3238	212	3472	222	3706	232	3940	242	4175	252	4408	263	12	33	18
19	36	12	2185	133	2445	143	2706	154	2995	164	3230	174	3491	184	3752	194	4013	205	12	36	19
20	36	12			2878	177	3133	187	3392	197	3651	208	3910	218	4168	228	4427	238	12	36	20
21	36	12					3612	218	3867	228	4123	238	4380	288	4635	259	4891	269	12	36	21

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.



To find the distributed safe load in net tons, divide the coefficient on opposite page corresponding to the number below by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in net tons by the span in feet between centres of supports.

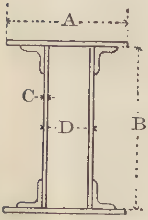
See opposite page for coefficients.

Weights include stiffeners.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Size of Corner Angles in Inches.*
1	12	18	3/8	5 x 3½ x 3/8
2	12	18	½	5 x 3½ x ½
3	12	18	5/8	5 x 3½ x 5/8
4	12	21	3/8	5 x 3½ x 3/8
5	12	21	½	5 x 3½ x ½
6	12	21	5/8	5 x 3½ x 5/8
7	12	24	3/8	5 x 3½ x 3/8
8	12	24	½	5 x 3½ x ½
9	12	24	5/8	5 x 3½ x 5/8
10	12	27	3/8	5 x 3½ x 3/8
11	12	27	½	5 x 3½ x ½
12	12	27	5/8	5 x 3½ x 5/8
13	12	30	3/8	5 x 3½ x 3/8
14	12	30	½	5 x 3½ x ½
15	12	30	5/8	5 x 3½ x 5/8
16	12	33	3/8	5 x 3½ x 3/8
17	12	33	½	5 x 3½ x ½
18	12	33	5/8	5 x 3½ x 5/8
19	12	36	3/8	5 x 3½ x 3/8
20	12	36	½	5 x 3½ x ½
21	12	36	5/8	5 x 3½ x 5/8

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	THICKNESS OF COVER PLATES IN INCHES. 3/8 Coefficient of Strength.	3/8 Wt. in Lbs. per Lin. Ft.	1/2 Coefficient of Strength.	1/2 Wt. in Lbs. per Lin. Ft.	5/8 Coefficient of Strength.	5/8 Wt. in Lbs. per Lin. Ft.	3/4 Coefficient of Strength.	3/4 Wt. in Lbs. per Lin. Ft.	7/8 Coefficient of Strength.	7/8 Wt. in Lbs. per Lin. Ft.	1 Coefficient of Strength.	1 Wt. in Lbs. per Lin. Ft.	1 1/8 Coefficient of Strength.	1 1/8 Wt. in Lbs. per Lin. Ft.	1 1/4 Coefficient of Strength.	1 1/4 Wt. in Lbs. per Lin. Ft.	Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
1	18	16	1078	133	1252	146	1426	160	1600	173	1775	186	1950	199	2126	213	2301	227	16	18	1
2	18	16			1415	176	1587	189	1760	202	1932	216	2105	229	2280	242	2452	256	16	18	2
3	21	16	1312	142	1515	156	1718	169	1922	182	2126	195	2330	209	2536	222	2740	235	16	21	3
4	21	16			1725	188	1925	201	2126	215	2327	228	2530	241	2732	255	2935	268	16	21	4
5	24	16	1558	151	1790	165	2022	178	2295	191	2493	205	2722	218	2957	231	3190	244	16	24	5
6	24	16			2050	200	2280	214	2510	227	2740	240	2971	253	3202	267	3433	280	16	24	6
7	27	16	1816	161	2077	174	2338	187	2601	200	2855	214	3126	227	3390	240	3652	253	16	27	7
8	27	16			2390	213	2648	226	2908	239	3167	252	3427	266	3688	279	3950	292	16	27	8
9	30	16	2085	169	2376	183	2666	196	2957	210	3250	223	3542	236	3835	249	4130	263	16	30	9
10	30	16			2746	225	3033	238	3322	251	3611	265	3900	278	4190	291	4478	304	16	30	10
11	33	16	2427	178	2685	191	3006	205	3312	218	3647	231	3968	244	4293	258	4617	271	16	33	11
12	33	16			3117	236	3435	249	3752	263	4070	276	4388	289	4707	302	5025	316	16	33	12
13	36	16	2660	186	3035	199	3385	213	3735	226	4085	239	4435	252	4758	266	5110	279	16	36	13
14	36	16			3503	246	3850	260	4197	273	4542	286	4895	299	5240	313	5585	326	16	36	14
15	21	20	1507	156	1757	173	2012	190	2268	207	2525	224	2781	240	3043	258	3300	275	20	21	15
16	21	20			1973	208	2235	225	2482	242	2742	259	2995	275	3252	292	3507	310	20	21	16
17	24	20	1781	165	2112	182	2365	199	2657	216	2950	233	3240	249	3537	267	3830	284	20	24	17
18	24	20			2345	220	2635	237	2925	254	3215	271	3505	287	3797	304	4090	322	20	24	18

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.



To find the distributed safe load in net tons, divide the coefficient on opposite page corresponding to the number below by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in net tons by the span in feet between centres of supports.

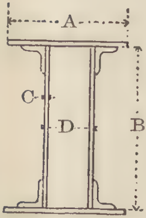
See opposite page for coefficients.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Width of (D) in Inches.*	*Size of Corner Angles in Inches.*
1	16	18	3/8	8	3½ x 3½ x 3/8
2	16	18	½	8	3½ x 3½ x ½
3	16	21	3/8	8	3½ x 3½ x 3/8
4	16	21	½	8	3½ x 3½ x ½
5	16	24	3/8	8	3½ x 3½ x 3/8
6	16	24	½	8	3½ x 3½ x ½
7	16	27	3/8	8	3½ x 3½ x 3/8
8	16	27	½	8	3½ x 3½ x ½
9	16	30	3/8	8	3½ x 3½ x 3/8
10	16	30	½	8	3½ x 3½ x ½
11	16	33	3/8	8	3½ x 3½ x 3/8
12	16	33	½	8	3½ x 3½ x ½
13	16	36	3/8	8	3½ x 3½ x 3/8
14	16	36	½	8	3½ x 3½ x ½
15	20	21	3/8	11	4 x 3½ x 3/8
16	20	21	½	11	4 x 3½ x ½
17	20	24	3/8	11	4 x 3½ x 3/8
18	20	24	½	11	4 x 3½ x ½

THICKNESS OF COVER PLATES IN INCHES.

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	3/8 Coefficient of Strength.	3/8 Wt. in Lbs. per Lin. Ft.	1/2 Coefficient of Strength.	1/2 Wt. in Lbs. per Lin. Ft.	5/8 Coefficient of Strength.	5/8 Wt. in Lbs. per Lin. Ft.	3/4 Coefficient of Strength.	3/4 Wt. in Lbs. per Lin. Ft.	7/8 Coefficient of Strength.	7/8 Wt. in Lbs. per Lin. Ft.	1 Coefficient of Strength.	1 Wt. in Lbs. per Lin. Ft.	1 1/8 Coefficient of Strength.	1 1/8 Wt. in Lbs. per Lin. Ft.	1 1/4 Coefficient of Strength.	1 1/4 Wt. in Lbs. per Lin. Ft.	Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
19	27	20	2066	174	2392	191	2723	209	3052	225	3382	242	3712	259	4043	276	4375	293	20	27	19
20	27	20			2723	232	3048	249	3375	266	3701	283	4030	299	4357	317	4685	334	20	27	20
21	30	20	2362	184	2728	208	3095	225	3460	241	3827	259	4193	275	4561	292	4930	208	20	30	21
22	30	20			3116	244	3478	262	3842	278	5046	295	4570	312	4933	329	5300	346	20	30	22
23	33	20	2731	191	3135	225	3537	242	3947	259	4342	276	4746	292	5150	310	5555	327	20	33	23
24	33	20			3525	255	3925	272	4293	288	4728	306	5125	322	5526	339	5927	357	20	33	24
25	36	20	2991	199	3431	217	3870	234	4310	250	4750	268	5195	284	5632	301	6073	319	20	36	25
26	36	20			3908	266	4385	283	4791	299	5257	317	5700	333	6132	350	6571	367	20	36	26
27	24	24			2580	204	2930	224	3280	244	3630	265	3985	285	4333	306	4687	326	24	24	27
28	24	24			2695	234	3043	263	3392	283	3742	303	4092	324	4443	344	4795	365	24	24	28
29	27	24			3012	213	3401	233	3800	253	4194	274	4589	294	4960	315	5381	335	24	27	29
30	27	24			3158	256	3550	276	3942	296	4336	317	4730	337	5125	358	5520	378	24	27	30
31	30	24			3416	222	3852	242	4292	263	4731	283	5170	303	5610	324	6047	344	24	30	31
32	30	24			3597	267	4033	287	4470	308	4907	328	5346	348	5785	369	6223	389	24	30	32
33	33	24			3838	231	4320	251	4802	272	5285	292	5745	313	6252	333	6385	353	24	33	33
34	33	24			4128	277	4538	297	5020	318	5500	338	5958	359	6466	379	6948	399	24	33	34
35	36	24			4480	237	5005	258	5530	278	6042	298	6587	319	7110	329	7638	349	24	36	35
36	36	24			4737	288	5260	309	5783	329	6307	349	6837	372	7356	390	7886	411	24	36	36

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.



To find the distributed safe load in net tons, divide the coefficient on opposite page corresponding to the number below by the length of span in feet.

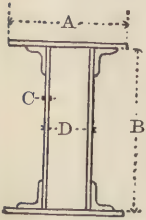
To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in net tons by the span in feet between centres of supports.

See opposite page for coefficients.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Width of (D) in Inches.*	*Size of Corner Angles in Inches.*
19	20	27	3/8	11	4 x 3½ x 3/8
20	20	27	½	11	4 x 3½ x ½
21	20	30	3/8	11	4 x 3½ x 3/8
22	20	30	½	11	4 x 3½ x ½
23	20	33	3/8	11	4 x 3½ x 3/8
24	20	33	½	11	4 x 3½ x ½
25	20	36	3/8	11	4 x 3½ x 3/8
26	20	36	½	11	4 x 3½ x ½
27	24	24	3/8	13	5 x 4 x 3/8
28	24	24	½	13	5 x 4 x ½
29	24	27	3/8	13	5 x 4 x 3/8
30	24	27	½	13	5 x 4 x ½
31	24	30	3/8	13	5 x 4 x 3/8
32	24	30	½	13	5 x 4 x ½
33	24	33	3/8	13	5 x 4 x 3/8
34	24	33	½	13	5 x 4 x ½
35	24	36	3/8	13	5 x 4 x 3/8
36	24	36	½	13	5 x 4 x ½

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	THICKNESS OF COVER PLATES IN INCHES. 3/8		1/2		5/8		3/4		7/8		1		1 1/8		1 1/4		Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
			Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.	Coefficient of Strength.	Wt. in Lbs. per Lin. Ft.			
37	30	30			3866	243	4417	269	4972	294	5518	320	6071	345	6625	371	7227	396	30	30	37
38	30	30			4047	288	4597	314	5146	336	5695	365	6247	390	6798	416	7351	441	30	30	38
39	33	30			4307	251	4938	274	5545	299	6152	325	6760	350	7368	381	7977	406	30	33	39
40	33	30			4553	298	5157	323	5762	349	6367	375	7973	400	7581	426	8188	451	30	33	40
41	36	30			5047	259	5678	386	6340	310	7001	335	7670	361	8326	386	8988	412	30	36	41
42	36	30			5277	309	5935	334	6593	360	7253	385	7920	411	8575	436	9236	461	30	36	42
43	39	30			5301	267	6018	292	6736	318	7453	343	8182	369	8892	394	9611	420	30	39	43
44	39	30			5560	320	6325	345	7041	371	7757	396	8473	422	9191	447	9910	473	30	39	44
45	42	30			5802	275	6575	300	7348	326	8351	351	8896	377	9681	402	10446	428	30	42	45
46	42	30			6161	330	6932	355	7653	381	8475	406	9297	432	10020	457	10793	483	30	42	46
47	36	36			5560	280	6255	311	7151	341	7947	372	8752	402	9542	433	10341	464	36	36	47
48	36	36			5817	331	6610	362	7405	392	8200	423	9002	453	9791	484	10587	515	36	36	48
49	39	36			5886	287	6750	318	7613	349	8478	380	9343	411	10210	441	11076	472	36	39	49
50	39	36			6195	342	7057	373	7918	400	8781	431	9645	462	10510	492	11248	523	36	39	50
51	42	36			6456	295	7362	326	8293	357	9225	387	10151	418	11090	448	12033	479	36	42	51
52	42	36			6792	380	7720	411	8646	441	9577	472	10507	502	11439	533	12370	564	36	42	52

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.

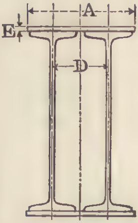


To find the distributed safe load in net tons, divide the coefficient on opposite page corresponding to the number below by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in net tons by the span in feet between centres of supports.

See opposite page for coefficients.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Width of (D) in Inches.*	*Size of Corner Angles in Inches.*
37	30	30	3/8	18	5 x 4 x 3/8
38	30	30	1/2	18	5 x 4 x 1/2
39	30	33	3/8	18	5 x 4 x 3/8
40	30	33	1/2	18	5 x 4 x 1/2
41	30	36	3/8	18	5 x 4 x 3/8
42	30	36	1/2	18	5 x 4 x 1/2
43	30	39	3/8	18	5 x 4 x 3/8
44	30	39	1/2	18	5 x 4 x 1/2
45	30	42	3/8	18	5 x 4 x 3/8
46	30	42	1/2	18	5 x 4 x 1/2
47	36	36	3/8	24	5 x 4 x 3/8
48	36	36	1/2	24	5 x 4 x 1/2
49	36	39	3/8	24	5 x 4 x 3/8
50	36	39	1/2	24	5 x 4 x 1/2
51	36	42	3/8	24	5 x 4 x 3/8
52	36	42	1/2	24	5 x 4 x 1/2



STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.

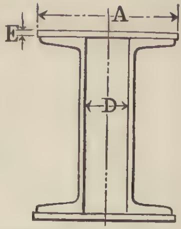
To find the distributed safe load in net tons, divide the coefficient of distributed load by length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in net tons by the span in feet between centres of supports.

Fibre stress 15,000 lbs. per square inch.

Size of Beam in Inches.	*Section Number and Weight.*		*Width of Cover (A) in Inches.*	*Thickness (E) of Cover in Inches.*	*Space (D) in Inches.*	*Total Weight in Pounds per Foot.*	*Coefficient for Distributed Load in Net Tons.*	*Add to Previous Coefficient for Each Pound Increase in Weight of 2 I.*	*Add to Previous Coefficient for Each 1/16" Increase Depth of Cover Plates.*
	Section Number.	*Weight of One I. Lbs. per Ft.*							
10	100B	25.0	12	½	6¼	94	452	2.62	33.04
10	102B	35.0	12	½	6	114	518	2.62	33.04
12	120B	31.5	12	½	6	107	606	3.12	39.44
12	122B	40.5	12	½	5¾	124	682	3.12	39.44
12	124B	50.0	14	½	7½	151	824		47.04
12	125B	55.0	14	½	7½	161	871	3.15	47.04
15	150B	42.0	14	⅝	7¾	147	1065	3.93	58.53
15	152B	50.0	14	⅝	7½	163	1148	3.92	58.53
15	154B	60.0	14	⅝	7¼	183	1265	3.92	58.53
15	156B	70.0	14	⅝	7	203	1377	3.92	58.53
18	180B	55.0	16	¾	8¼	195	1721	4.79	81.37
18	183B	70.0	16	¾	8	225	1889	4.79	81.37
18	186B	85.0	16	¾	7½	255	2049	4.79	81.37
20	200B	65.0	16	¾	8	215	2074	5.23	90.32
20	203B	80.0	16	¾	7¾	245	2272	5.23	90.32
20	206B	95.0	16	¾	7½	275	2443	5.23	123.28
24	240B	80.0	18	¾	9½	255	2993	6.25	123.28

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.



To find the distributed safe load in net tons, divide the coefficient of distributed load by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in net tons by the span in feet between centres of supports.

Fibre stress 15,000 lbs. per square inch.

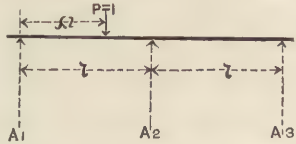
Size of Channels in Inches.	*Section Number and Weight.*		*Width of Cover (A) in Inches.*	*Thickness (E) of Cover in Inches.*	*Space (D) in Inches.*	*Total Weight in Pounds per Foot.*	*Coefficient for Distributed Load in Net Tons.*	*Add to Previous Coefficient for Each Pound Increase in Weight of 2 Chan.*
	Section Number.	*Weight of 1 Channel. Pounds per Foot.*						
15	150C	33.0	14	½	7	117	788	3.93
15	150C	33.0	14	⅝	7	129	899	3.93
15	150C	33.0	14	¾	7	141	1011	3.93
15	154C	50.0	14	⅝	6	163	1050	3.92
15	154C	50.0	14	¾	6	175	1160	3.92
15	154C	50.0	14	⅞	6	187	1270	3.92
12	120C	20.5	12	⅜	5½	75	396	3.14
12	120C	20.5	12	½	5½	85	471	3.14
12	120C	20.5	12	⅝	5½	96	546	3.14
12	123C	35.0	12	½	5	114	575	3.12
12	123C	35.0	12	⅝	5	125	649	3.12
12	123C	35.0	12	¾	5	135	723	3.12
10	100C	15.0	10	⅜	4	59	253	2.62
10	100C	15.0	10	½	4	68	304	2.62
10	100C	15.0	10	⅝	4	76	354	2.62
10	102C	25.0	10	⅜	3½	79	306	2.61
10	102C	25.0	10	½	3½	88	356	2.61
10	102C	25.0	10	⅝	3½	96	405	2.61

REACTIONS FOR CONTINUOUS GIRDERS.

$$A_1 = +P(1-\lambda) - \frac{P}{2}\lambda(1-\lambda^2)$$

$$A_2 = P\lambda + \frac{P}{2}\lambda(1-\lambda^2)$$

$$A_3 = -\frac{P}{4}\lambda(1-\lambda^2)$$



6 Panels.	$\frac{1}{6}$	$\frac{2}{6}$	$\frac{3}{6}$	$\frac{4}{6}$	$\frac{5}{6}$	λ			
A_1 +	0.7928	0.5926	0.4062	0.2407	0.1030				
A_2 +	0.2476	0.4815	0.6875	0.8519	0.9606				
A_3 −	0.0405	0.0741	0.0938	0.0926	0.0637				

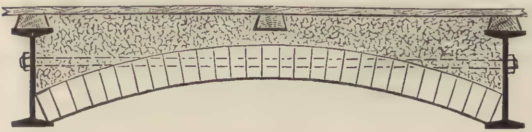
7 Panels.	$\frac{1}{7}$	$\frac{2}{7}$	$\frac{3}{7}$	$\frac{4}{7}$	$\frac{5}{7}$	$\frac{6}{7}$	λ		
A_1 +	0.8221	0.6487	0.4839	0.3324	0.1982	0.0860			
A_2 +	0.2129	0.4169	0.6036	0.7639	0.8893	0.9708			
A_3 −	0.0350	0.0656	0.0875	0.0962	0.0875	0.0569			

8 Panels.	$\frac{1}{8}$	$\frac{2}{8}$	$\frac{3}{8}$	$\frac{4}{8}$	$\frac{5}{8}$	$\frac{6}{8}$	$\frac{7}{8}$	λ	
A_2 +	0.1865	0.3672	0.5362	0.6875	0.8155	0.9141	0.9776		
A_1 +	0.8442	0.6914	0.5444	0.4062	0.2798	0.1679	0.0737		
A_3 −	0.0308	0.0586	0.0806	0.0937	0.0953	0.0820	0.0513		

9 Panels.	$\frac{1}{9}$	$\frac{2}{9}$	$\frac{3}{9}$	$\frac{4}{9}$	$\frac{5}{9}$	$\frac{6}{9}$	$\frac{7}{9}$	$\frac{8}{9}$	λ
A_2 +	0.1661	0.3278	0.4814	0.6227	0.7476	0.8519	0.9314	0.9822	
A_1 +	0.8614	0.7250	0.5926	0.4664	0.3484	0.2407	0.1454	0.0644	
A_3 −	0.0275	0.0528	0.0740	0.0891	0.0960	0.0926	0.0768	0.0466	

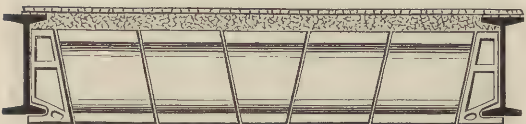
10 Panels.	$\frac{1}{10}$	$\frac{2}{10}$	$\frac{3}{10}$	$\frac{4}{10}$	$\frac{5}{10}$	$\frac{6}{10}$	$\frac{7}{10}$	$\frac{8}{10}$	$\frac{9}{10}$
A_2 +	0.1495	0.2960	0.4365	0.5680	0.6875	0.7920	0.8785	0.9440	0.9855
A_1 +	0.8752	0.7520	0.6317	0.5160	0.4062	0.3040	0.2107	0.1280	0.0572
A_3 −	0.0248	0.0480	0.0683	0.0840	0.0938	0.0960	0.0893	0.0720	0.0572

FIRE-PROOF FLOORING.

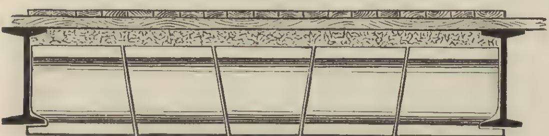


No. 1.
ORDINARY BRICK.

No. 2.
HOLLOW TILE, SIDE METHOD.



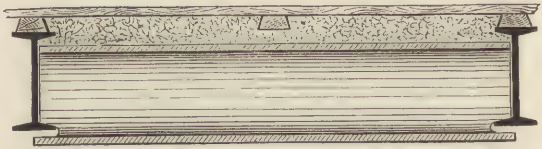
No. 3.
HOLLOW TILE, SIDE AND END METHOD.



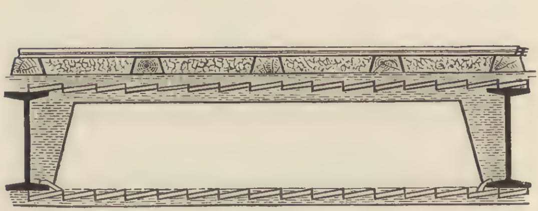
No. 4.
HOLLOW TILE, END METHOD.

FIRE-PROOF FLOORING.

No. 5.
HOLLOW TILE FOR LIGHT FLOORS.



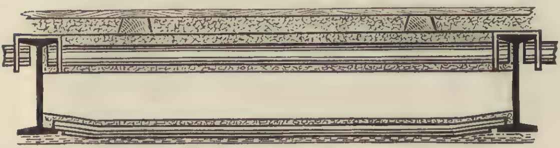
No. 6.
FAWCETT FLOOR.



No. 7.
EXPANDED METAL.

No. 8.
ROEBLING WIRE CLOTH.

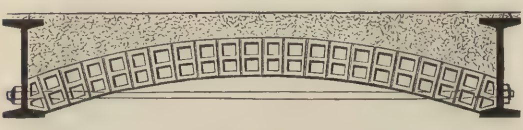
FIRE-PROOF FLOORING.



No. 9.
COLUMBIAN SYSTEM.

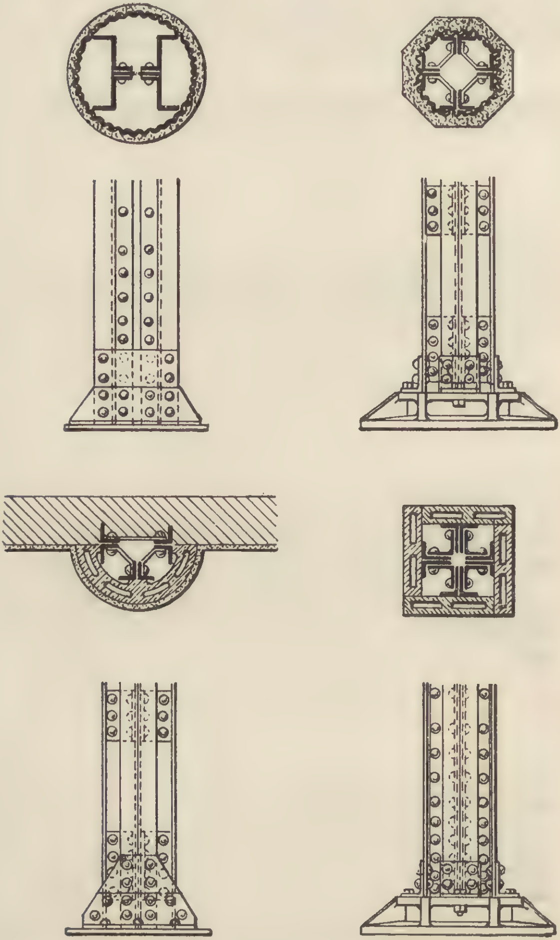
No. 10.
METROPOLITAN SYSTEM.

No. 11.
CORRUGATED IRON ARCH.

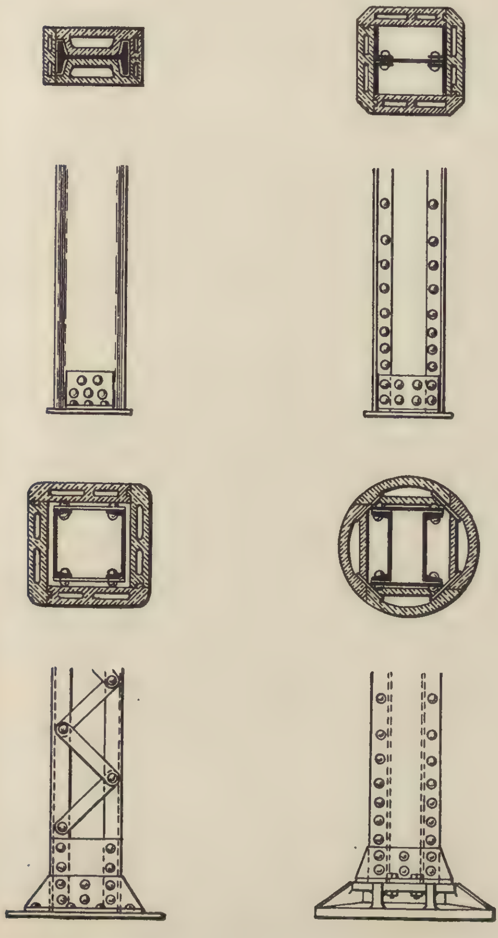


No. 12.
LONG SPAN SEGMENTAL ARCH.

FIRE-PROOFING AND BASES OF COLUMNS.



FIRE-PROOFING AND BASES OF COLUMNS.



FIRE-PROOF FLOORS.

Fire-proof floors, hitherto made by filling the spaces between the floor beams with segmental arches of ordinary brick, and leveled with concrete, are now usually either flat arches constructed of special tiles that encase the flanges of the beams, or composite flooring made by various methods of incorporating metallic constructions within a mass of concrete.

The hollow tiles are either of a dense or porous structure, and in different systems have the webs of the tile either parallel with or at right angles to the floor beams, termed the "side" or "end construction" respectively. The illustrations show some of the general types of floor construction, and the weights and usual spans are given in the following table. The concrete used in fire-proofing will vary from 120 to 164 pounds per cubic foot, according to the kind of cement and stone used. Ordinary natural cement and light furnace slag will weigh as low as 120, whereas heavy Portland cement and limestone or trap rock will weigh 164 pounds per cubic foot. (See page 290.)

The segmental arch of ordinary brick, Fig. I, is used for spacing of 4 to 6 feet, or even much greater if sufficient rise can be allowed and the arch stiffened with a suitable backing of concrete, the rise of the arch being preferably not less than one tenth of the span. The weight of floor for $4\frac{1}{2}$-inch brick will be about 45 pounds per square foot of surface, and an addition for concrete backing equivalent to from 120 to 164 pounds per cubic foot.

For special cases, segmental arches of hollow tile, as in Fig. 12, with a rise not less than one-eighth of the span, the following dimensions will apply for loads of 150 pounds per square foot :

Arches	4″ thick.	Safe span,	8′	Wt. of brick,	20	lbs. per sq. ft.
"	6″ "	" "	14′	" "	30	" " "
"	8″ "	" "	20′	" "	40	" " "

adding to the weight as before for concrete backing.

The composite floors, Nos. 7 to 11, are formed by incorporating special metallic constructions in a mass of concrete. Floors of this class are now successfully used ; definite particulars can be procured from the manufacturers.

On account of the strength obtained from the incorporated metal work, these floors are usually much lighter than the brick arches.

The following table gives the usual spans and weights of flat arches for flooring :

Flooring Proportioned for an Evenly Distributed Load of 150 lbs. per Sq. Foot.

Depth of Arch in Inches.	*Span of Arch. Load 150 lbs. per Square Foot.*	*Span of Arch. Load 100 lbs. per Square Foot.*	*Weight of Hollow Brick per Sq. Ft. in Pounds.*		*Sizes of Steel Floor Beams for Given Spans and Under for Ordinary Spans of Fire Proof Flooring.*					
			Side Method.	*End Method.*	*12 Feet.*	*15 Feet.*	*18 Feet.*	*21 Feet.*	*24 Feet.*	*27 Feet.*
6′	3′ 3″	4′ 0″	29	22	6 inch. No. 60 B.	8 inch. No. 80 B.	9 inch. No. 90 B.	10 inch. No. 100 B.	12 inch. No. 120 B.	12 inch. No. 121 B.
7′	3′ 9″	4′ 6″	32	27	6 inch. No. 61 B.	8 inch. No. 80 B.	9 inch. No. 90 B.	12 inch. No. 120 B.	12 inch. No. 120 B.	15 inch. No. 150 B.
8′	4′ 0″	5′ 0″	35	30	7 inch. No. 70 B.	8 inch. No. 80 B.	9 inch. No. 90 B.	12 inch. No. 120 B.	12 inch. No. 120 B.	15 inch. No. 150 B.
9′	4′ 6″	5′ 6″	38	32	7 inch. No. 70 B.	8 inch. No. 80 B.	10 inch. No. 100 B.	12 inch. No. 120 B.	12 inch. No. 121 B.	15 inch. No. 150 B.
10′	5′ 0″	6′ 0″	42	34	7 inch. No. 70 B.	9 inch. No. 90 B.	10 inch. No. 100 B.	12 inch. No. 120 B.	15 inch. No. 150 B.	15 inch. No. 150 B.
12′	6′ 6″	7′ 6″	48	40	8 inch. No. 80 B.	9 inch. No. 91 B.	12 inch. No. 120 B.	12 inch. No. 122 B.	15 inch. No. 150 B.	15 inch No. 152 B.

Add to this the weight of covering material, and if plastered add 8 to 10 pounds per square foot additional.

TIE RODS FOR BEAMS SUPPORTING BRICK ARCHES.

The horizontal thrust of brick arches is as follows:

$$\text{Pressure in lbs. per lineal foot of arch} = \frac{1.5\, W\, S^2}{R}$$

$W =$ load in lbs. per square foot.

$S =$ span of arch in feet.

$R =$ rise in inches.

Place the tie rods as low as possible through the webs of the beams, and so spaced that the pressure of arches as obtained above will not produce a greater stress than 15,000 pounds per square inch of the least section of the bolt.

Ordinarily it will be found necessary to limit the spacing of the tie rods to avoid excessive bending stress on the outer beams of the floor, or to prevent this bending stress being transferred to the walls of the building. The ability of the outer beams to resist the horizontal bending action caused by the pressure of the arches is determined as follows:

From the formulæ given in table, page 112 to 113, for the safe load on a beam acting at right angles to the web, or in the direction of the flanges, which is based on a fibre stress of 16,000 pounds per square inch, we have for semi-continuous beams:

$$L = \sqrt{\frac{1300\ A\ F}{w}} \text{ for } \mathbf{I} \text{ beams.}$$

$$L = \sqrt{\frac{1650\ A\ F}{w}} \text{ for channels.}$$

$$L = \sqrt{\frac{2650\ A\ F}{w}} \text{ for angles.}$$

where w is the lateral pressure in pounds per lineal foot,

$A =$ sectional area of beam in square inches,

$F =$ width of flange in inches,

$L =$ distance between supports in feet.

In practice this spacing L is not imperative, but can be used as a guide, since concrete or flooring material will distribute the pressure to some extent over the length of the beam.

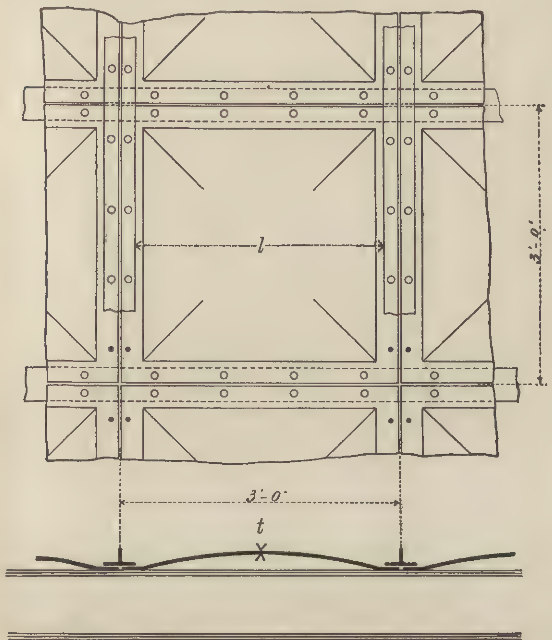
BUCKLED PLATES.

Buckled plates are usually made three feet square and from one-quarter inch to one-half inch thick. They can be made of any desired size or thickness, or extended length, having several buckles in a single plate.

They are usually riveted to the supporting beams and the transverse joint supported by a ⊥ or other suitable section, as indicated on the cut.

Experiment shows considerable advantage by having the edges properly secured.

Buckled plates, if used inverted—that is, with the buckle suspended—develop from three to four times as much strength as if used as shown in sketch.



The strength of buckled plates may be given by the following formula:*

$$D = \frac{100\,k\,h\,t - 0.175\,g\,l^2}{6\,h + 15\,t} \times t$$

D = total concentrated load in pounds.
g = uniform load in pounds per square foot.
h = depth of buckle in inches.
l = length of buckle in inches.
t = thickness in inches.
k = permissible stress in pounds per square inch.

If we assume $g = 120$ lbs. per square foot, and $k = 6{,}000$ lbs. per square inch, we get the following values for D, for various dimensions of plates:

TOTAL CONCENTRATED LOAD IN POUNDS, ALLOWING FOR A DISTRIBUTED LOAD OF 120 POUNDS PER SQUARE FOOT.

Size of Plate.	36 *Inches Square.*	42 *Inches Square.*	48 *Inches Square.*	54 *Inches Square.*	60 *Inches Square.*
Thickness in Inches.	2 *Inches Depth of Buckle.*				
$\frac{1}{4}$	4350	4200	4000	3800	3550
$\frac{5}{16}$	6500	6350	6100	5900	5600
$\frac{3}{8}$	9000	8800	8550	8300	8000
$\frac{7}{16}$	11700	11500	11200	10900	10600
$\frac{1}{2}$	14700	14400	14100	13800	13400
	2½ *Inches Depth of Buckle.*				
$\frac{1}{4}$	4600	4500	4350	4200	4000
$\frac{5}{16}$	7000	6850	6650	6450	6250
$\frac{3}{8}$	9750	9550	9350	9100	8850
$\frac{7}{16}$	12750	12550	12350	12050	11750
$\frac{1}{2}$	16050	15850	15600	15300	15000
	3 *Inches Depth of Buckle.*				
$\frac{1}{4}$	4850	4750	4600	4450	4300
$\frac{5}{16}$	7350	7250	7050	6900	6700
$\frac{3}{8}$	10250	10150	9950	9750	9500
$\frac{7}{16}$	13550	13350	13150	12950	12700
$\frac{1}{2}$	17100	16900	16700	16450	16150

* Winkler, "Querconstructionen," Vienna, 1884.

The formula shows that the concentrated load and the total uniform load are independent of l. This, of course, is only correct as long as the buckled plate is not subject to local deformations, say within the limits given in the previous table. The total uniform load a buckled plate can carry, follows from the above formula as:

$$P = 4\ k\ h\ t.$$

If we assume $k = 6{,}000$ lbs. per square inch, we get the following:

TOTAL UNIFORMLY DISTRIBUTED LOAD ON ANY SIZE PLATE OF GIVEN THICKNESS AND DEPTH OF BUCKLE.

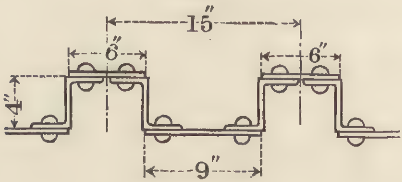
Depth of Buckle.	*2 Inches.*	*$2\frac{1}{2}$ Inches.*	*3 Inches.*
Thickness of Plate in Inches.	*Total Loads in Pounds.*		
$\frac{1}{4}$	12000	15000	18000
$\frac{5}{16}$	15000	18750	22500
$\frac{3}{8}$	18000	22500	27000
$\frac{7}{16}$	21000	26250	31500
$\frac{1}{2}$	24000	30000	36000

WEIGHT OF BUCKLED PLATES THREE FEET SQUARE.

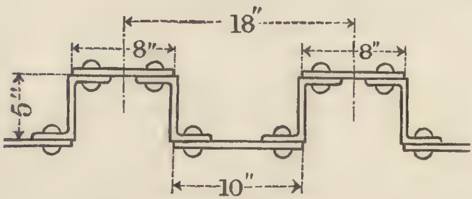
Thickness of Plate in Inches.	*Weight of One Plate in Pounds.*	*Size and Weight of T.*	*Weight in Pounds per Square Foot of Floor.*
$\frac{3}{16}$	68	4 x 2 T = 20 lbs.	$9\frac{1}{2}$
$\frac{1}{4}$	92	4 x 2 T = 20 "	12
$\frac{5}{16}$	114	4 x 3 T = 25 "	15
$\frac{3}{8}$	139	4 x $3\frac{1}{2}$ T = 30 "	18
$\frac{7}{16}$	160	4 x 4 T = 35 "	22
$\frac{1}{2}$	184	4 x $4\frac{1}{2}$ T = 40 "	25

PENCOYD Z BAR FLOORING.

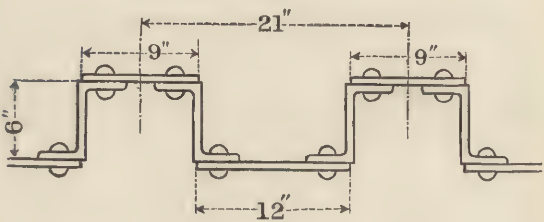
No. 1.



No. 2.



No. 3.

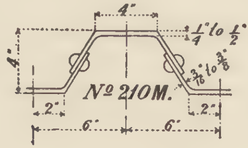


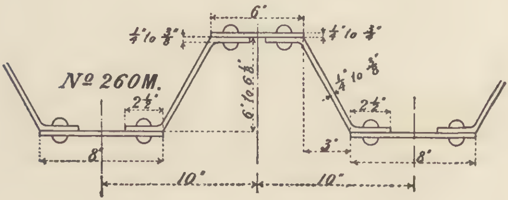
Divide the coefficient in last column, on the opposite page, by the span of the floor in feet. The quotient will be the safe load in net tons, evenly distributed, for each foot of width of floor.

PENCOYD Z BAR FLOORING.

Section Number.	*Thickness of Z Bars.*	*Thickness of Plates.*	*Weight in Pounds per Square Foot.*	*Resistance per Foot of Width.*	*Coefficient for Distributed Load in Net Tons, per Foot of Width.*
1	1/4	1/4	25.9	9.3	46.7
1	1/4	3/8	31.0	12.0	60.0
1	1/4	1/2	36.1	14.7	73.7
1	5/16	1/4	29.1	10.4	52.0
1	5/16	3/8	34.2	12.9	64.5
1	5/16	1/2	39.3	15.7	78.5
1	3/8	1/4	32.3	11.4	57.2
1	3/8	3/8	37.4	14.0	70.0
1	3/8	1/2	42.5	16.7	83.5
2	5/16	5/16	32.1	14.3	71.5
2	5/16	7/16	37.3	17.6	88.0
2	5/16	9/16	42.3	20.9	104.7
2	3/8	5/16	35.2	15.5	77.5
2	3/8	7/16	40.3	18.8	94.0
2	3/8	9/16	45.4	22.1	110.7
2	7/16	5/16	38.4	16.6	83.2
2	7/16	7/16	43.5	20.0	100.0
2	7/16	9/16	48.6	23.3	116.5
3	3/8	3/8	39.3	20.3	101.7
3	3/8	1/2	44.3	24.1	120.7
3	3/8	5/8	49.5	28.1	140.5
3	7/16	3/8	42.4	21.7	108.7
3	7/16	1/2	47.5	25.4	127.0
3	7/16	5/8	52.6	29.4	147.0
3	1/2	3/8	45.5	23.1	115.5
3	1/2	1/2	50.6	26.7	133.5
3	1/2	5/8	55.7	30.7	153.6

PENCOYD CORRUGATED FLOORING.





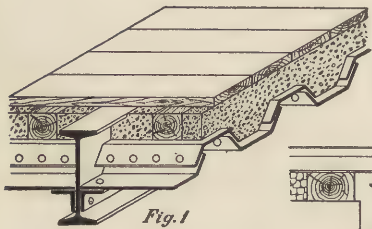


Fig. 1

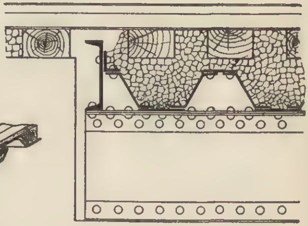


Fig. 3

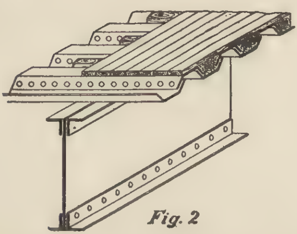


Fig. 2

PENCOYD CORRUGATED FLOORING.

Sections Nos. 210 M and 260 M are extensively used for floors of bridges and buildings. No. 210 M is generally used in buildings; No. 260 M is used for bridge-floors.

The following table gives the weights and strengths of each section for different thicknesses:

WEIGHT AND STRENGTH OF CORRUGATED FLOORING.

Section Number.	*Flange Thickness in Inches.*	*Web Thickness in Inches.*	*Weight in Pounds per Square Foot.*	*Resistance per Foot of Width.*	*Coefficient for Distributed Load in Net Tons, per Foot of Width.*
210M	1/4	3/16	14.8	4.4	22.0
210M	5/16	15/64	18.4	5.5	27.5
210M	3/8	9/32	21.9	6.6	33.0
210M	7/16	21/64	25.5	7.7	38.7
210M	1/2	3/8	29.1	8.9	44.4
260M	1/4	1/4	20.0	10.5	52.5
260M	3/8	1/4	23.6	13.2	66.0
260M	1/2	1/4	27.1	15.9	79.5
260M	5/8	1/4	30.7	18.6	93.0
260M	3/8	5/16	26.5	14.3	71.5
260M	1/2	5/16	30.1	17.0	85.0
260M	5/8	5/16	33.7	19.7	98.5
260M	3/4	5/16	37.2	22.4	112.0
260M	3/8	3/8	29.4	15.3	76.5
260M	1/2	3/8	32.9	18.1	90.5
260M	5/8	3/8	36.5	20.9	104.5
260M	3/4	3/8	40.1	23.7	118.5

The resistances and coefficients for distributed loads in net tons are for each foot in width; the latter for fibre stress of 15,000 pounds per square inch. To find the load for any span, divide the coefficient by the length of span in feet; the quotient is the distributed load in net tons, which produces fibre stress on the material, as aforesaid.

The following tables give safe loads for varying thickness of each section, based on the fibre stress aforesaid.

PENCOYD CORRUGATED FLOORING.

Loads in pounds per square foot of floor for a fibre stress of 15,000 pounds per square inch.

The figures in small type under the load in pounds are the corresponding centre deflections in inches. Those to the right of the dark line are where the centre deflection exceeds $\frac{1}{360}$ part of the span.

Section No. 210 M.

Weight of Material per Sq. Foot.	SPAN IN FEET.										
	6	7	8	9	10	11	12	13	14	15	16
14.8	1222 .15	898 .21	688 .28	543 .35	440 .43	364 .52	306 .62	260 .73	224 .84	196 .97	172 1.10
18.4	1528 .15	1122 .21	859 .28	679 .35	550 .43	455 .52	382 .62	325 .73	281 .84	244 .97	215 1.10
21.9	1833 .15	1347 .21	1031 .28	815 .35	660 .43	545 .52	458 .62	391 .73	337 .84	293 .97	258 1.10
25.5	2150 .15	1579 .21	1209 .28	956 .35	774 .43	640 .52	533 .62	458 .73	395 .84	344 .97	302 1.10
29.1	2467 .15	1812 .21	1388 .28	1096 .35	888 .43	734 .52	617 .62	525 .73	453 .84	395 .97	347 1.10

Section No. 260 M.

Weight of Material per Sq. Foot.	8	9	10	11	12	13	14	15	16	17	18
20.0	1641 .17	1309 .22	1050 .27	868 .32	729 .38	621 .45	536 .52	467 60	410 .68	363 .77	324 .86
23.6	2063 .16	1630 .21	1320 .26	1091 .31	917 .37	781 .44	693 .51	587 .58	516 .65	457 .74	407 .83
27.1	2484 .16	1963 .20	1590 .25	1314 .30	1104 .35	941 .41	811 .48	707 .55	620 .62	550 .71	491 .80
30.7	2906 .15	2296 .19	1860 .24	1537 .29	1292 .34	1101 .40	949 .47	827 .54	727 .61	644 .69	574 .77
26.5	2234 .16	1765 .20	1430 .25	1182 .30	993 .36	846 .43	730 .50	636 .57	559 .65	495 .73	441 .82
30.1	2656 .16	2099 .20	1700 .24	1405 .29	1181 .35	1006 .41	867 .48	756 .55	664 .63	588 .71	525 .79
33.7	3078 .15	2432 .19	1970 .24	1628 .29	1368 .34	1166 .40	1005 .46	876 .53	770 .60	682 .68	608 .76
37.2	3500 .15	2765 .20	2240 .23	1851 .28	1556 .33	1325 .39	1143 .45	996 .51	875 .58	775 .66	691 .74
29.4	2391 .16	1889 .20	1530 .24	1264 .29	1063 .35	905 .41	781 .48	680 .55	598 .63	529 .71	472 .79
32.9	2828 .16	2235 .20	1810 .24	1496 .29	1264 .35	1071 .41	923 .48	804 .55	707 .62	626 .70	559 .39
36.5	3266 .15	2580 .19	2090 .24	1727 .29	1451 .34	1237 .40	1066 .46	929 .53	816 .61	723 .69	645 .77
40.1	3703 .14	2926 .18	2370 .23	1959 .28	1646 .33	1402 .38	1209 .44	1053 .51	926 .58	820 .65	731 .73

PENCOYD CORRUGATED FLOORING.

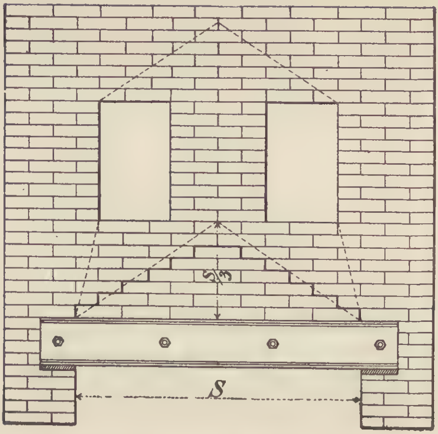
Loads in pounds per square foot which cause a deflection equal to $\frac{1}{400}$ of the span.

Section No. 210 M.

Weight of Material per Square Foot.	SPAN IN FEET.										
	5	6	7	8	9	10	11	12	13	14	15
14.8	2460	1400	900	600	420	300	230	180	140	110	90
18.4	3000	1750	1100	740	520	380	290	220	170	140	110
21.9	3600	2120	1300	900	630	460	340	250	210	170	130
25.5	4200	2500	1570	1050	740	540	400	310	240	200	160
29.1	4800	2850	1800	1200	850	620	460	360	280	220	180

Section No. 260 M.

Weight of Material per Square Foot.	SPAN IN FEET.										
	8	9	10	11	12	13	14	15	16	17	18
20.0	2420	1650	1200	880	680	540	430	350	290	240	200
23.6	3050	2200	1580	1200	910	710	570	460	380	310	260
27.1	3670	2650	1910	1450	1140	890	720	580	470	390	330
30.7	4650	3310	2350	1760	1380	1040	860	690	570	480	400
26.5	3300	2240	1630	1250	990	780	636	500	420	350	290
30.1	3920	2670	1940	1480	1170	950	770	620	510	430	360
33.7	4920	3280	2360	1790	1410	1140	910	750	620	510	430
37.2	5600	3980	2830	2220	1720	1330	1070	870	730	610	510
29.4	3830	2550	1840	1390	1090	860	690	550	460	390	320
32.9	4530	3220	2290	1720	1290	1010	810	660	540	460	380
36.5	5230	3720	2640	1990	1550	1210	970	780	640	540	450
40.1	5930	4210	3160	2350	1820	1410	1130	930	770	640	530



BEAMS SUPPORTING BRICK WALLS.

When the masonry alone, without any floor attachment, is supported, the load on the girder will vary according to several conditions. If the masonry is not thoroughly bonded throughout, or if great inflexibility is desired, it may be necessary to consider the whole mass of wall as sustained by the girder.

If the wall has no openings, and the brick is laid with the usual bond, the material incumbent on the girder would be indicated by the dark line—height, one-fourth of the span. It is best to consider this as a triangle, whose height equals one-third of span, as in lower dotted line; and as the weight of brick walls is nearly 10 lbs. per square foot for each inch of thickness, from these data we find the bending stress on the beam to be the same as that caused by a distributed load, in pounds equal to

$$\frac{25 \times \text{square of span in feet} \times \text{thickness of wall in inches.}}{9}$$

And from the table of distributed loads suitable beams can be selected, with proper limitations, for deflection, if the spans are long, to avoid cracking of wall. If the wall has

openings as illustrated, it is necessary to consider the mass of brickwork, indicated by the upper course of dotted lines, as supported by the beams, which can be selected accordingly.

It is usually best to use two or more beams bolted together to give a better bearing or to insure lateral rigidity, and the following tables give suitable beams for solid brick walls properly bonded, selected to deflect less than $\frac{1}{360}$ of spans up to 10 feet, and $\frac{1}{500}$ of spans 15 to 20 feet.

Particulars for separators for these beams can be found on page 257.

Thickness of Wall in Inches.	*SPANS IN FEET.*					
	8 or 9 feet.	*10 or 11 feet.*	*12 or 13 feet.*	*14 or 15 feet.*	*16 or 17 feet.*	*18 or 20 feet.*
9	2—4″ No. 40 B	2—5″ No. 50 B	2—7″ No. 70 B	2—8″ No. 80 B	2—9″ No. 90 B	2—12″ No. 120 B
13	2—4″ No. 40 B	2—6″ No. 60 B	2—7″ No. 70 B	2—8″ No. 80 B	2—9″ No. 90 B	2—12″ No. 120 B
18	2—5″ No. 50 B	2—7″ No. 70 B	2—8″ No. 80 B	2—9″ No. 90 B	2—10″ No. 100 B	2—12″ No. 120 B
22	2—5″ No. 50 B	2—7″ No. 70 B	2—8″ No. 80 B	2—9″ No. 90 B	2—10″ No. 100 B	2—12″ No. 120 B

If beams are used to support the whole length of a wall, and the span exceeds 16 feet, the entire weight of the wall should be calculated as resting on the beam, as excessive deflection might push out the supports from under the beam and destroy the structure.

If beams support flooring as well as weight of wall, the beam sections must be selected to take the additional load with deflection, as before stated.

STRUTS OF ROLLED SECTIONS.

In the following consideration of struts of various sections the least radius of gyration of the cross-section, around an axis through the centre of gravity, is assumed as the effective radius of the strut. The tables on pages 160 to 165 are the classified averages of an extensive series of experiments.

The tables for destructive pressures represent the ultimate load at the point of failure.

The greatest safe loads are the aforesaid crippling loads, divided by the factors of safety hereafter described.

As is well known, the method of securing the ends of the struts exercises an important influence on their resistance to bending, as the member is held more or less rigidly in the direct line of thrust.

In the general tables, struts are classified in four divisions, viz.: "Fixed Ended," "Flat Ended," "Hinged Ended," and "Round Ended."

In the class of "fixed ends" the struts are supposed to be so rigidly attached at both ends to the contiguous parts of the structure that the attachment would not be severed if the member was subjected to the ultimate load. "Flat-ended" struts are supposed to have their ends flat and normal to the axis of length, but not rigidly attached to the adjoining parts. "Hinged ends" embrace the class which have both ends properly fitted with pins, or ball and socket joints, of substantial dimensions as compared with the section of the strut; the centres of these end joints being practically coincident with an axis passing through the centre of gravity of the section of the strut. "Round-ended" struts are those which have only central points of contact, such as balls or pins resting on flat plates, but still the centres of the balls or pins coincident with the proper axis of the strut.

If in hinged-ended struts the balls or pins are of comparatively insignificant diameter, it will be safest in such cases to consider the struts as round-ended.

If there should be any serious deviation of the centres of

round or hinged ends from the proper axis of the strut, there will be a reduction of resistance that cannot be estimated without knowing the exact conditions.

When the pins of hinged-end struts are of substantial diameter, well fitted, and exactly centered, experiment shows that the hinged-ended will be equally as strong as flat-ended struts. But a very slight inaccuracy of the centering rapidly reduces the resistance to lateral bending, and as it is almost impossible in practice to uniformly maintain the rigid accuracy required, it is considered best to allow for such inaccuracies to the extent given in the tables, which are the average of many experiments.

It is considered good practice to increase the factors of safety as the length of the strut is increased, owing to the greater inability of the long struts to resist cross strains, etc. For similar reasons we consider it advisable to increase the factor of safety for hinged and round ends in a greater ratio than for fixed or flat ends.

Presuming that one-third of the ultimate load would constitute the greatest safe load for the shortest struts, the following progressive factors of safety are adopted for the increasing lengths.

$$3. + .01 \frac{l}{r} \text{ for flat and fixed ends.}$$

$$3 + .015 \frac{l}{r} \text{ for hinged and round ends.}$$

$l =$ length of strut. $r =$ least radius of gyration.

From the above we derive the following factors of safety :

$\frac{l}{r}$	*Fixed and Flat Ends.*	*Hinged and Round Ends.*	$\frac{l}{r}$	*Fixed and Flat Ends.*	*Hinged and Round Ends.*	$\frac{l}{r}$	*Fixed and Flat Ends.*	*Hinged and Round Ends.*
20	3.2	3.3	110	4.1	4.65	200	5.0	6.0
30	3.3	3.45	120	4.2	4.8	210	5.1	6.15
40	3.4	3.6	130	4.3	4.95	220	5.2	6.3
50	3.5	3.75	140	4 4	5.1	230	5.3	6.45
60	3.6	3.9	150	4.5	5.25	240	5.4	6.6
70	3.7	4.05	160	4.6	5.4	250	5.5	6.75
80	3.8	4.2	170	4.7	5.55	260	5.6	6.9
90	3.9	4.35	180	4.8	5.7	270	5.7	7.05
100	4.0	4.5	190	4.9	5.85	280	5.8	7.2

STRUTS OF WROUGHT IRON OR EXTREME SOFT STEEL.—No. 1.

Destructive pressure in pounds per square inch.

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	46000	46000	46000	44000
30	43000	43000	43000	40250
40	40000	40000	40000	36500
50	38000	38000	38000	33500
60	36000	36000	36000	30500
70	34000	34000	33750	27750
80	32000	32000	31500	25000
90	31000	30900	29750	22750
100	30000	29800	28000	20500
110	29000	28050	26150	18500
120	28000	26300	24300	16500
130	26750	24900	22650	14650
140	25500	23500	21000	12800
150	24250	21750	18750	11150
160	23000	20000	16500	9500
170	21500	18400	14650	8500
180	20000	16800	12800	7500
190	18750	15650	11800	6750
200	17500	14500	10800	6000
210	16250	13600	9800	5500
220	15000	12700	8800	5000
230	14000	11950	8150	4650
240	13000	11200	7500	4300
250	12000	10500	7000	4050
260	11000	9800	6500	3800
270	10500	9150	6100	3500
280	10000	8500	5700	3200
290	9500	7850	5350	3000
300	9000	7200	5000	2800
310	8500	6600	4750	2650
320	8000	6000	4500	2500
330	7500	5550	4250	2300
340	7000	5100	4000	2100
350	6750	4700	3750	2000
360	6500	4300	3500	1900
370	6150	3900	3250	1800
380	5800	3500	3000	1700
390	5500	3250	2750	1600
400	5200	3000	2500	1500

STRUTS OF WROUGHT IRON OR EXTREME SOFT STEEL.—No. 2.

Greatest safe load in pounds per square inch of cross-section for vertical struts. Both ends are supposed to be secured as indicated at the head of each column.

If both ends are not secured alike, take a mean proportional between the values given for the classes to which each end belongs.

If the strut is hinged by any uncertain method, so that the centres of pins and axis of strut may not coincide, or the pins may be relatively small and loosely fitted, it is best in such cases to consider the strut as "round ended."

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	14380	14380	13940	13330
30	13030	13030	12460	11670
40	11760	11760	11110	10140
50	10860	10860	10130	8930
60	10000	10000	9230	7820
70	9190	9190	8330	6850
80	8420	8420	7500	5950
90	7950	7920	6840	5230
100	7500	7450	6220	4560
110	7070	6840	5620	3980
120	6670	6260	5060	3440
130	6220	5790	4580	2960
140	5800	5340	4120	2510
150	5390	4830	3570	2120
160	5000	4350	3060	1760
170	4570	3920	2640	1530
180	4170	3500	2250	1310
190	3830	3190	2020	1150
200	3500	2900	1800	1000
210	3190	2670	1590	890
220	2880	2440	1400	790
230	2640	2250	1260	720
240	2410	2070	1140	650
250	2180	1910	1040	600
260	1960	1750	940	550
270	1840	1610	870	500
280	1720	1460	790	440
290	1610	1330	730	410
300	1500	1200	670	370
310	1390	1080	620	350
320	1290	970	580	320
330	1190	880	540	290
340	1090	800	490	260
350	1040	720	450	240
360	980	650	420	230
370	920	580	380	210
380	850	510	340	200
390	800	470	310	80
400	740	430	280	70

STRUTS OF MEDIUM STEEL.—No. 3.

Destructive pressure in pounds per square inch, for steel of medium grade, tensile strength, about 70,000 lbs. per square inch.

For extreme soft steel, use table No. 1.

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	70000	70000	70000	66900
30	51000	51000	51000	47700
40	46000	46000	46000	41900
50	44000	44000	44000	38800
60	42000	42000	42000	35600
70	40000	40000	39700	32600
80	38000	38000	37400	29700
90	36100	36000	34700	26500
100	34200	34000	31900	23400
110	33100	32000	29800	21100
120	31900	30000	27700	18800
130	30100	28000	25500	16500
140	28200	26000	23200	14200
150	26800	24000	20700	12300
160	25300	22000	18100	10400
170	23400	20000	15900	9240
180	21400	18000	13700	8030
190	19400	16200	12200	6990
200	17900	14800	11000	6120
210	16200	13600	9800	5500
220	15000	12700	8800	5000
230	14000	11950	8100	4650
240	13000	11200	7500	4300
250	12000	10500	7000	4050
260	11000	9800	6500	3800
270	10500	9150	6100	3500
280	10000	8500	5700	3200
290	9500	7850	5330	3000
300	9000	7200	5000	2800

STRUTS OF MEDIUM STEEL.—No. 4.

Greatest safe load for steel of medium grade, tensile strength about 70,000 lbs. For extreme soft steel, use table No. 2.

The figures are the working loads in pounds per square inch for vertical struts. Both ends are supposed to be secured as indicated at the head of each column.

If both ends are not secured alike, take a mean proportional between the values given for the classes to which each end belongs.

If the strut is hinged by any uncertain method so that the centres of pins and axis of strut may not coincide, or the pins may be relatively small and loosely fitted, it is best in such cases to consider the strut as "round ended."

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	21900	21900	21200	20300
30	15400	15400	14800	13800
40	13500	13500	12800	11600
50	12600	12600	11700	10300
60	11700	11700	10800	9130
70	10800	10800	9800	8050
80	10000	10000	8900	7070
90	9260	9230	7980	6090
100	8550	8500	7090	5200
110	8070	7800	6410	4540
120	7590	7140	5770	3920
130	7000	6510	5150	3330
140	6410	5910	4550	2780
150	5950	5330	3940	2340
160	5500	4780	3350	1920
170	4980	4250	2860	1660
180	4460	3750	2400	1410
190	3960	3310	2080	1190
200	3580	2960	1830	1020
210	3180	2670	1590	890
220	2880	2440	1400	790
230	2640	2250	1250	720
240	2410	2070	1140	650
250	2180	1910	1040	600
260	1960	1750	940	550
270	1840	1610	860	500
280	1720	1460	790	440
290	1610	1330	720	410
300	1500	1200	670	370

STRUTS OF HARD STEEL.—No. 5.

Destructive pressure in pounds per square inch for hard steel, tensile strength about 100,000 lbs.

For softer steel, see table No. 3.

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	100000	100000	100000	95600
30	74000	74000	74000	69300
40	62000	62000	62000	56600
50	60000	60000	60000	52900
60	58000	58000	58000	49100
70	55500	55500	55100	45300
80	53000	53000	52200	41400
90	49900	49700	47800	36600
100	46800	46500	43700	32000
110	44700	43200	40400	28500
120	42600	40000	36900	25100
130	39400	36700	33500	21600
140	36300	33500	29900	18200
150	34200	30700	26500	15700
160	32200	28000	23100	13300
170	29800	25500	20300	11800
180	27400	23000	17500	10300
190	25100	21000	15800	9060
200	22900	19000	14100	7860
210	20300	17200	12400	6950
220	18300	15500	10700	6100
230	16900	14400	9820	5600
240	15500	13400	8960	5140
250	14200	12400	8270	4780
260	12900	11500	7630	4460
270	12200	10600	7060	4050
280	11400	9700	6500	3650
290	10900	9000	6130	3440
300	10600	8500	5890	3300

STRUTS OF HARD STEEL.—No. 6.

Greatest safe load for hard steel, tensile strength about 100,000 lbs.
For soft steel, see table No. 4.

The figures are the working loads in pounds per square inch for vertical struts. Both ends are supposed to be secured as indicated at the head of each column.

If both ends are not secured alike, take a mean proportional between the values given for the classes to which each end belongs.

If the strut is hinged by any uncertain method, so that the centres of pins and axis of strut may not coincide, or the pins may be relatively small and loosely fitted, it is best in such cases to consider the strut as "round ended."

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	31200	31200	30300	29000
30	22400	22400	21400	20100
40	18200	18200	17200	15700
50	17100	17100	16000	14100
60	16100	16100	14900	12600
70	15000	15000	13600	11200
80	13900	13900	12400	9860
90	12800	12700	11000	8410
100	11700	11600	9710	7110
110	10900	10500	8670	6130
120	10100	9520	7690	5230
130	9160	8530	6770	4360
140	8250	7610	5860	3570
150	7600	6820	5050	2990
160	7000	6090	4280	2460
170	6340	5420	3660	2130
180	5710	4790	3070	1810
190	5120	4280	2700	1550
200	4580	3800	2350	1310
210	3980	3370	2020	1130
220	3520	2980	1700	970
230	3190	2720	1500	870
240	2870	2480	1360	780
250	2580	2250	1220	710
260	2300	2050	1100	650
270	2240	1860	1000	570
280	1960	1670	900	510
290	1850	1520	830	470
300	1800	1420	780	440

ROLLED STRUCTURAL SHAPES AS STRUTS.

The following tables of safe loads for rolled struts are derived from previous table No. 4, and from the columns given for flat-ended bearings.

When steel of medium grade is used, say 65,000 pounds tensile strength or greater, the tables derived from No. 4 can be used, described as applicable to steel of medium grade.

In all cases the strut is supposed to be vertical. In short struts this distinction is immaterial, but in long horizontal struts some allowance is necessary for the deflection due to weight.

If the struts are rigidly connected at the ends to contiguous parts of a structure, the increase of resistance becomes considerable in extremely long struts, and proper allowance can be made by using the columns for "Fixed Ends" in table No. 4. On the contrary, if the end bearing of the strut is to be of uncertain character or fit, it will be best to reduce the safe load to that in the columns for "Round Ends," in the same table. In these working tables the calculations are made to apply to the mean thicknesses of each shape. Where more exact results are required for thicknesses above or below the mean, the true radius of gyration of the section will be found on pages 188 to 216. But within the range of variation of thickness possible for any shape, the tables may be accepted as practically correct.

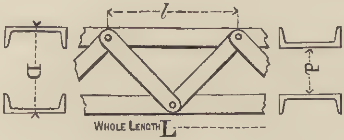
For **I** beams, table No. 7 applies to cases where the strut is braced in the direction of the flanges, so that failure could occur in the direction of the web only. For unbraced **I** struts use table No. 8. Likewise for channel bars used as struts, and braced to resist failure in the directions of the flanges, use table No. 9 same as for latticed channels.

For a pair of latticed channels, which form a more perfect column than single rolled sections, the safe loads are given for various conditions of the end bearings, as described on pages 158 and 159. On the table No. 9 the distances D or d

for flanges inward or outward, respectively, make the radii of gyration equal for either direction of axis, parallel to web or to the flanges.

Under each length of struts in the table, l represents the greatest distance apart in feet that centres of lateral bracing can be spaced, without allowing weakness in the individual channels. The distance l is obtained as shown in last example, that is, by making $\frac{l}{r} = \frac{L}{R}$.

l = length between bracing.
L = total length of strut.
r = least radius of gyration for a single channel.
R = least radius of gyration for the whole section.



It is customary to make l much shorter than given in the tables, the figures given being useful as a guide. If a column is composed of four angles, forming the corners of a square, and properly latticed as explained above, find the radius of gyration of the combined section, as described on page 186, and then the working resistance from tables Nos. 2 to 6, or the safe load can be ascertained approximately from table No. 16 on page 180 for square columns.

When a pair of angles are tied together forming a single strut

take the greatest radius of gyration, around axis A B, in column No. IX, page 207, for a single angle as the least radius of gyration of the pair, and proceed as before described.

PENCOYD I BEAMS AS STRUTS—No. 7.

GREATEST SAFE LOAD IN POUNDS PER SQUARE INCH OF SECTION FOR STEEL OF MEDIUM GRADE.

For struts secured against failure in the direction of the flanges and liable to bend only in the direction of the web.

Size of I Beam in Inches.	LENGTH IN FEET.									
	6	8	10	12	14	16	18	20	22	24
	Greatest safe load in pounds per square inch of section.									
24 $r=9.35$						21430	19500	17780	16280	15240
20 $r=7.64$					20330	18120	16270	15080	14330	13810
18 $r=6.85$				21010	18520	16390	15040	14240	13690	13260
15 $r=5.87$			21510	18520	16000	14720	13960	13400	12960	12670
12 $r=4.74$		21680	18000	15320	14180	13440	12910	12570	12190	11630
10 $r=3.97$		18760	15350	14050	13220	12710	12300	11660	11140	10600
9 $r=3.50$	21400	16710	14370	13370	12730	12260	11550	10970	10370	9820
8 $r=3.16$	19730	15320	13770	12910	12390	11630	10990	10320	9730	9150
7 $r=2.78$	17640	14330	13130	12510	11660	10920	10180	9510	8870	8250
6 $r=2.33$	15220	13360	12520	11540	10630	9810	9030	8290	7580	6910
5 $r=1.95$	13930	12660	11560	10490	9530	8610	7750	6950	6190	5460
4 $r=1.58$	12910	11630	10320	9150	8060	7040	6100	5220	4400	3650
3 $r=1.18$	11610	9890	8380	7010	5770	4640	3620	2860	2370	2000

PENCOYD I BEAMS AS STRUTS.—No. 8.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR STEEL OF MEDIUM GRADE.

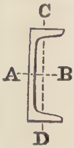
When struts are unsupported, or free to bend in the direction of the flanges.
r = least radius of gyration for mean thickness of each shape.

Section Number.	*Size of Beam in Inches.*		*LENGTH IN FEET.*									
			4	6	8	10	12	14	16	18	20	22
			Greatest safe load in pounds per square inch of section.									
240B	24	$r = 1.33$	14080	12320	10630	9210	7920	6740	5660	4650	3730	3010
200B	20	$r = 1.18$	13420	11590	9890	8380	7010	5770	4640	3620	2860	2370
203B	20	$r = 1.27$	13800	12080	10350	8900	7580	6370	5260	4250	3350	2730
206B	20	$r = 1.38$	14290	12480	10870	9460	8190	7030	5960	4970	4060	3260
180B	18	$r = 1.12$	13150	11340	9560	8000	6600	5330	4180	3210	2570	2150
183B	18	$r = 1.20$	13500	11700	10000	8500	7140	5910	4780	3750	2960	2440
186B	18	$r = 1.32$	14040	12290	10580	9160	7870	6680	5590	4590	3670	2960
150B	15	$r = 1.07$	12970	11080	9250	7660	6230	4940	3780	2900	2360	1960
152B	15	$r = 1.13$	13210	11390	9610	8070	6670	5410	4260	3270	2610	2190
154B	15	$r = 1.24$	13670	11940	10210	8730	7390	6180	5060	4040	3180	2600
156B	15	$r = 1.32$	14030	12290	10580	9160	7870	6680	5590	4590	3670	2960
120B	12	$r = 1.00$	12730	10640	8790	7140	5680	4360	3240	2530	2070	1690
122B	12	$r = 1.09$	13050	11180	9380	7800	6380	5100	3940	3020	2440	2030
124B	12	$r = 1.19$	13460	11650	9950	8440	7080	5840	4710	3680	2910	2410
125B	12	$r = 1.24$	13670	11940	10210	8730	7390	6180	5060	4040	3180	2600
100B	10	$r = 0.94$	12550	10270	8350	6660	5150	3810	2830	2260	1820	1450
102B	10	$r = 1.03$	12830	10820	8990	7370	5920	4620	3460	2680	2200	1810
90B	9	$r = 0.87$	12230	9780	7780	6030	4490	3200	2430	1940	1520	
80B	8	$r = 0.81$	11770	9310	7240	5440	3860	2740	2130	1650	1250	
70B	7	$r = 0.76$	11430	8880	6740	4900	3330	2420	1870	1410		
60B	6	$r = 0.69$	10870	8210	5960	4060	2710	2020	1490			
63B	6	$r = 1.11$	13130	11290	9500	7930	6530	5250	4100	3150	2530	2110
67B	6	$r = 1.24$	13670	11940	10210	8730	7390	6180	5060	4040	3180	2600
50B	5	$r = 0.63$	10300	7520	5200	3290	2280	1650				
40B	4	$r = 0.57$	9670	6740	4340	2660	1870	1270				
30B	3	$r = 0.52$	9060	6000	3550	2240	1510					

TABLE OF STRUTS.—No. 9.

LATTICED CHANNEL STRUTS.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR MEDIUM STEEL.



For a pair of braced channels, or for a single channel secured from flexure in the direction of flanges and liable to fail only in the direction of the web *C D*.

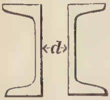
r in the marginal columns gives the radius of gyration for axis *A B*, or for either axis of the combined pair of channels. See description, page 167.

Size of Channels.	*Condition of Ends.*	*LENGTH IN FEET.*							
		6	8	10	12	14	16	18	20
		Greatest safe load in pounds per square inch of section.							
15 ins.	Fixed.	22000	22000	20420	17430	15280	14250	13590	13080
$r=5.49$	Flat.	22000	22000	20420	17430	15280	14250	13590	13080
$D=12.48$	Hinged.	22000	22000	19720	16740	14630	13600	12900	12300
$d=9.14$	Round.	22000	22000	18670	15460	13630	12580	11720	11020
		1.03	1.38	1.72	2.06	2.41	2.76	3.10	3.45
12 ins.	Fixed.	22000	20520	16870	14760	13770	13110	12690	12310
$r=4.42$	Flat.	22000	20520	16870	14760	13770	13110	12690	12310
$D=10.13$	Hinged.	22000	19810	16180	14090	13100	12330	11790	11390
$d=7.25$	Round.	22000	18790	14940	13130	11970	11060	10400	9810
		1.10	1.47	1.84	2.20	2.57	2.94	3.30	3.67
10 ins.	Fixed.	22000	17440	14700	13590	12890	12450	11810	11220
$r=3.66$	Flat.	22000	17440	14700	13590	12890	12450	11810	11220
$D=8.55$	Hinged.	22000	16740	14040	12900	12060	11520	10920	10280
$d=5.80$	Round.	22000	15460	13070	11720	10730	10010	9270	8540
		1.22	1.63	2.03	2.44	2.85	3.25	3.66	4.07
9 ins.	Fixed.	20810	16200	14170	13190	12620	12070	11380	10720
$r=3.38$	Flat.	20810	16200	14170	13190	12620	12070	11380	10720
$D=7.90$	Hinged.	20100	15540	13500	12430	11720	11160	10440	9770
$d=5.34$	Round.	19130	14390	12470	11180	10330	9530	8730	7950
		1.25	1.67	2.08	2.50	2.92	3.33	3.75	4.17
8 ins.	Fixed.	18880	14900	13500	12730	12160	11370	10640	10000
$r=3.00$	Flat.	18880	14900	13500	12730	12160	11370	10640	10000
$D=7.08$	Hinged.	18170	14240	12800	11870	11240	10430	9680	8900
$d=4.62$	Round.	16950	13270	11600	10490	9630	8720	7850	7070
		1.33	1.78	2.22	2.66	3.11	3.55	4.00	4.44
7 ins.	Fixed.	16570	13930	12870	12220	11320	10490	9770	9100
$r=2.60$	Flat.	16570	13930	12870	12220	11320	10490	9760	9060
$D=6.22$	Hinged.	15900	13260	12040	11300	10370	9500	8620	7780
$d=3.85$	Round.	14700	12180	10700	9690	8650	7670	6770	5890
		1.45	1.94	2.42	2.91	3.39	3.88	4.36	4.85
6 ins.	Fixed.	14860	13170	12360	11340	10400	9580	8800	8210
$r=2.24$	Flat.	14860	13170	12360	11340	10400	9560	8760	8000
$D=5.44$	Hinged.	14200	12400	11440	10380	9390	8380	7410	6610
$d=3.21$	Round.	13240	11140	9900	8690	7550	6510	5520	4730
		1.55	2.06	2.58	3.09	3.61	4.12	4.64	5.16

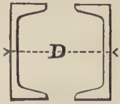
TABLE OF STRUTS.—No. 9.

LATTICED CHANNEL STRUTS.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR STEEL OF MEDIUM GRADE.



The channels must be connected so as to insure unity of action, and separated not less than the distances *D* or *d* respectively given in inches in the marginal column. Figures in smaller type under each length represent the greatest distance apart in feet on each channel that centres of lateral bracing should be placed.



LENGTH IN FEET.								Condition of Ends.	Size of Channels.
22	24	26	28	30	32	34	36		
Greatest safe load in pounds per square inch of section.									
12720	12450	12070	11590	11220	10830	10450	10100	Fixed.	**15** ins.
12720	12450	12070	11590	11220	10830	10450	10100	Flat.	$r=$ 5.49
11860	11520	11160	10690	10280	9810	9450	9040	Hinged.	$D=$12.48
10480	10010	9530	9030	8540	8060	7620	7200	Round.	$d=$ 9.14
3.79	4.14	4.48	4.83	5.17	5.52	5.86	6.19		
11730	11260	10760	10320	9890	9490	9100	8710	Fixed.	**12** ins.
11730	11260	10760	10320	9890	9470	9060	8660	Flat.	$r=$ 4.42
10830	10320	9780	9300	8770	8270	7780	7290	Hinged.	$D=$10.13
9170	8590	7990	7470	6930	6400	5880	5400	Round.	$d=$ 7.25
4.04	4.41	4.77	5.14	5.51	5.87	6.24	6.61		
10630	10110	9610	9130	8670	8310	8000	7690	Fixed.	**10** ins.
10630	10110	9590	9100	8620	8160	7700	7270	Flat.	$r=$ 3.66
9670	9040	8420	7820	7240	6750	6320	5900	Hinged.	$D=$ 8.55
7840	7200	6560	5930	5350	4880	4450	4040	Round.	$d=$ 5.80
4.47	4.88	5.29	5.69	6.10	6.50	6.91	7.32		
10150	9610	9100	8590	8240	7900	7550	7130	Fixed.	**9** ins.
10150	9600	9060	8540	8040	7560	7090	6650	Flat.	$r=$ 3.38
9100	8420	7780	7140	6650	6180	5730	5290	Hinged.	$D=$ 7.90
7260	6560	5890	5250	4770	4320	3880	3460	Round.	$d=$ 5.34
4.58	5.00	5.42	5.85	6.25	6.67	7.09	7.50		
9410	8830	8360	7970	7590	7120	6650	6230	Fixed.	**8** ins.
9380	8790	8220	7670	7140	6630	6150	5680	Flat.	$r=$ 3.00
8160	7450	6820	6280	5770	5270	4790	4310	Hinged.	$D=$ 7.08
6290	5560	4940	4420	3920	3450	3000	2600	Round.	$d=$ 4.62
4.88	5.33	5.77	6.22	6.66	7.10	7.55	7.99		
8480	8030	7590	7050	6500	6060	5640	5180	Fixed.	**7** ins.
8390	7750	7140	6560	6000	5460	4950	4450	Flat.	$r=$ 2.60
6990	6360	5770	5200	4640	4080	3530	3050	Hinged.	$D=$ 6.22
5100	4490	3920	3380	2870	2440	2050	1760	Round.	$d=$ 3.85
5.33	5.81	6.30	6.78	7.27	7.75	8.23	8.72		
7690	7090	6450	5950	5460	4910	4350	3850	Fixed.	**6** ins.
7280	6600	5950	5330	4740	4180	3660	3210	Flat.	$r=$ 2.24
5910	5240	4590	3940	3320	2800	2330	2010	Hinged.	$D=$ 5.44
4050	3420	2820	2340	1900	1820	1360	1140	Round.	$d=$ 3.21
5.67	6.19	6.70	7.22	7.73	8.25	8.77	9.28		

PENCOYD CHANNELS AS STRUTS—No. 10.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR STEEL OF MEDIUM GRADE.

When struts are unsupported, or free to bend in the direction of the flanges.
r = least radius of gyration for mean thickness of each size.

Section Number.	*Size of Channels in Inches.*	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18	20
		Greatest safe load in pounds per sq. in. of section.									
	15										
154C—155C	r=1.03	19360	12830	10820	8990	7370	5920	4620	3470	2680	2200
150C—153C	r= .90	17160	12380	10000	8030	6310	4780	3460	2590	2070	1660
	12										
123C—124C	r= .95	18040	12570	10340	8430	6740	5240	3910	2900	2300	1870
120C—122C	r= .79	15320	11630	9150	7040	5220	3650	2610	2020	1560	
128C	r= .70	14370	10970	8300	6080	4180	2790	2070	1540		
	10										
102C—104C	r= .77	15150	11490	8970	6840	5010	3440	2480	1920	1450	
100C—101C	r= .71	14470	11050	8400	6200	4300	2880	2130	1600		
	9										
92C— 93C	r= .73	14680	11200	8600	6420	4550	3060	2250	1710	1250	
90C— 91C	r= .67	14130	10670	7980	5720	3790	2560	1900	1370		
	8										
82C— 84C	r= .69	14290	10870	8210	5960	4060	2710	2020	1490		
80C— 81C	r= .62	13670	10210	7400	5060	3190	2210	1590			
	7										
72C— 74C	r= .66	14030	10580	7860	5590	3670	2480	1840	1320		
70C— 71C	r= .58	13340	9790	6880	4490	2760	1940	1330			
	6										
61C— 63C	r= .59	13420	9890	7010	4640	2860	2000	1400			
60C	r= .54	13010	9310	6310	3860	2400	1660				
	5										
50C— 52C	r= .49	12680	8650	5500	3100	2020	1280				
	4										
40C— 42C	r= .45	12380	8030	4780	2590	1660					
	3										
30C— 32C	r= .42	12040	7520	4180	2280	1390					

PENCOYD Z BARS AS STRUTS.—No. 11.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR STEEL OF MEDIUM GRADE.

When struts are unsupported, or free to bend in the direction of the flanges.
r = least radius of gyration for mean thickness of each size.

Sec. No.	Size in Inches.	*LENGTH IN FEET.*								
		2	4	6	8	10	12	14	16	18
		Greatest safe load in pounds per sq. in. of section.								
67Z $r = .81$	$3\frac{9}{16}$x$6\frac{1}{16}$x$3\frac{9}{16}$x$\frac{13}{16}$	15590	11780	9310	7240	5440	3860	2740	2130	1650
64Z. $r = .81$	$3\frac{9}{16}$x$6\frac{1}{16}$x$3\frac{9}{16}$x$\frac{5}{8}$	15590	11780	9310	7240	5440	3860	2710	2130	1650
61Z $r = .83$	$3\frac{9}{16}$x$6\frac{1}{16}$x$3\frac{9}{16}$x$\frac{7}{16}$	15950	11970	9480	7430	5640	4070	2890	2230	1750
56Z $r = .72$	$3\frac{1}{4}$x5 x$3\frac{1}{4}$x$\frac{11}{16}$	14680	11200	8600	6420	4550	3060	2250	1710	1250
54Z $r = .74$	$3\frac{9}{32}$x$5\frac{1}{16}$x$3\frac{9}{32}$x$\frac{9}{16}$	14790	11290	8700	6530	4670	3150	2310	1760	1300
51Z $r = .75$	$3\frac{1}{4}$x$5\frac{1}{16}$x$3\frac{1}{4}$x$\frac{3}{8}$	14900	11370	8790	6640	4780	3240	2360	1810	1360
47Z $r = .66$	$3\frac{1}{8}$x$4\frac{1}{16}$x$3\frac{1}{8}$x$\frac{11}{16}$	14030	10580	7860	5590	3670	2480	1840	1320	
44Z $r = .65$	$3\frac{1}{32}$x$4\frac{1}{16}$x$3\frac{1}{32}$x$\frac{1}{2}$	14080	10490	7750	5460	3550	2410	1770	1260	
41Z $r = .65$	$2\frac{15}{16}$x$4\frac{1}{16}$x$2\frac{15}{16}$x$\frac{5}{16}$	14080	11490	7750	5460	3550	2410	1770	1260	
34Z $r = .54$	$2\frac{11}{16}$x$3\frac{1}{32}$x$2\frac{11}{16}$x$\frac{15}{32}$	13010	9310	6310	3860	2400	1660			
31Z $r = .55$	$2\frac{11}{16}$x$3\frac{1}{16}$x$2\frac{11}{16}$x$\frac{5}{16}$	13090	9440	6450	4020	2480	1720			

PENCOYD ANGLES AS STRUTS.—No. 12.

GREATEST SAFE LOAD IN POUNDS PER SQUARE INCH OF SECTION FOR STEEL OF MEDIUM GRADE.

r = least radius of gyration for mean thickness of each size.

Size of Angle in Inches.	*LENGTH IN FEET.*									
	2	4	6	8	10	12	14	16	18	20
	Greatest safe load in pounds per square inch of section.									
8 x 8 $r = 1.59$		15360	12940	11670	10360	9190	8100	7090	6160	5280
6 x 6 $r = 1.19$	21750	13460	11650	9950	8440	7080	5840	4710	3680	2910
5 x 5 $r = .99$	18710	12700	10580	8720	7060	5590	4270	3170	2480	2030
4 x 4 $r = .79$	15320	11630	9150	7040	5220	3650	2610	2020	1560	
$3\frac{1}{2}$ x $3\frac{1}{2}$ $r = .69$	14290	10880	8220	5980	4080	2700	2010	1480		
3 x 3 $r = .59$	13420	9890	7010	4640	2860	2000	1400			
$2\frac{3}{4}$ x $2\frac{3}{4}$ $r = .55$	13090	9440	6450	4020	2480	1720				
$2\frac{1}{2}$ x $2\frac{1}{2}$ $r = .49$	12680	8650	5500	3100	1990	1280				
$2\frac{1}{4}$ x $2\frac{1}{4}$ $r = .44$	12290	7860	4590	2480	1570					
2 x 2 $r = .39$	11560	6950	3550	1970						
$1\frac{3}{4}$ x $1\frac{3}{4}$ $r = .36$	11130	6310	2960	1660						
$1\frac{1}{2}$ x $1\frac{1}{2}$ $r = .28$	9560	4180	1800							
$1\frac{1}{4}$ x $1\frac{1}{4}$ $r = .26$	9060	3540	1510							
1 x 1 $r = .21$	7520	2280								

PENCOYD TEES AS STRUTS—No. 13.

GREATEST SAFE LOAD IN POUNDS PER SQUARE INCH OF SECTION FOR STEEL OF MEDIUM GRADE.

r = least radius of gyration of each size.

Size of Tee in Inches.	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18	20
	Greatest safe load in pounds per square inch of section.									
4 x 4 $r = .85$	16280	12110	9640	7610	5840	4280	3040	2330	1840	1430
$3\frac{1}{2}$ x $3\frac{1}{2}$ $r = .73$	14680	11200	8600	6420	4550	3060	2250	1710	1250	
3 x 3 $r = .62$	13670	10210	7390	5060	3190	2210	1590			
$2\frac{1}{2}$ x $2\frac{1}{2}$ $r = .54$	13010	9310	6310	3860	2400	1660				
$2\frac{1}{4}$ x $2\frac{1}{4}$ $r = .48$	12600	8500	5330	2960	1910	1200				
2 x 2 $r = .41$	11870	7330	3970	2170	1290					
$1\frac{3}{4}$ x $1\frac{3}{4}$ $r = .36$	11130	6310	2960	1660						
$1\frac{1}{2}$ x $1\frac{1}{2}$ $r = .32$	10400	5330	2340	1200						
$1\frac{1}{4}$ x $1\frac{1}{4}$ $r = .30$	10000	4780	2070							
1 x 1 $r = .26$	9060	3540	1510							

COLUMNS OF ROUND AND SQUARE SECTION.

Experiments on columns of this class are not very complete, especially as denoting the comparative values for the various end conditions. The following tables, Nos. 14 to 16, are derived partly from experiment on actual columns, extended and completed by comparison with the experiments on rolled struts from which all our previous tables of strut resistances are derived.

Table No. 4, page 163, is taken as the basis for the working values. On account of the more perfect symmetry of form possessed by round and square sections than the shapes for which this table was especially calculated, the safe loads per square inch of section are increased ten (10) per cent. for round columns, and five (5) per cent. for square columns. That is, the factors of safety previously given remain the same, the ultimate strength is supposed to be 10 and 5 per cent. respectively greater than the rolled struts.

The tables are calculated for certain thicknesses, varying from $\frac{1}{8}$ inch for 2-inch diameter up to $\frac{5}{8}$ inch for 12-inch diameter, as marked in the margins. At the same place R represents the radius of gyration for the diameter and thickness given. When the thickness varies but a little from that given, the strength per square inch of section can be accepted as practically unchanged. But when the variation becomes of importance, the radius of gyration corresponding to the altered thickness will have to be obtained, and the strength of the column then ascertained from table No. 4, as heretofore described.

The following table gives the values of the radius of gyration for round and square columns from 2 to 12 inches diameter, and from $\frac{1}{10}$ of an inch to 1 inch thick.

Example for Round Column :

What is the greatest safe load for a flat-ended round column 6 inches outer diameter, $\frac{1}{2}$ inch thick, 8.64 square inches area, and 18 feet long, $r = 1.95$ $\frac{l}{r} = 111$? By table No. 4, the corresponding safe load $= 7{,}730$ lbs. $+ 10$ per cent. $= 8{,}500$ lbs. per square inch of section, or 73,440 lbs. for the column.

No. 14.

RADII OF GYRATION FOR ROUND COLUMNS.

Outside Diameter of Column in Inches.	*Thickness in Inches Varying by Tenths.*									
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
	Corresponding Radius of Gyration in Inches.									
2	.67	.64	.61	.58	.56	.54	.52	.51	.50	.50
3	1.03	.99	.96	.93	.90	.88	.85	.83	.81	.79
4	1.38	1.35	1.31	1.28	1.25	1.22	1.19	1.16	1.14	1.12
5	1.73	1.70	1.66	1.63	1.60	1.57	1.54	1.51	1.48	1.46
6	2.08	2.05	2.02	1.98	1.95	1.92	1.89	1.86	1.83	1.80
7	2.43	2.40	2.36	2.33	2.30	2.27	2.24	2.21	2.18	2.15
8	2.79	2.76	2.72	2.69	2.66	2.62	2.59	2.56	2.53	2.50
9	3.15	3.11	3.08	3.04	3.01	2.97	2.94	2.91	2.88	2.85
10	3.51	3.47	3.44	3.40	3.37	3.33	3.30	3.27	3.23	3.20
11	3.86	3.82	3.79	3.75	3.72	3.68	3.65	3.62	3.58	3.55
12	4.21	4.18	4.15	4.11	4.08	4.04	4.01	3.97	3.94	3.90

RADII OF GYRATION FOR SQUARE COLUMNS.

Outer Diam. Across Flats in Inches.	*Thickness in Inches Varying by Tenths.*									
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
	Corresponding Radius of Gyration in Inches.									
2	.78	.74	.71	.68	.65	.63	.61	.59	.58	.58
3	1.18	1.14	1.11	1.08	1.04	1.01	.98	.96	.93	.91
4	1.59	1.55	1.51	1.47	1.44	1.41	1.38	1.35	1.32	1.29
5	2.00	1.96	1.92	1.89	1.85	1.81	1.78	1.75	1.71	1.68
6	2.41	2.37	2.33	2.29	2.25	2.21	2.18	2.15	2.11	2.08
7	2.82	2.78	2.74	2.70	2.66	2.62	2.58	2.55	2.51	2.48
8	3.23	3.19	3.15	3.11	3.07	3.03	2.99	2.96	2.92	2.89
9	3.63	3.59	3.55	3.51	3.48	3.44	3.40	3.36	3.32	3.29
10	4.04	4.00	3.96	3.92	3.88	3.84	3.80	3.77	3.73	3.70
11	4.45	4.41	4.37	4.33	4.29	4.25	4.21	4.17	4.13	4.10
12	4.86	4.82	4.78	4.74	4.70	4.66	4.62	4.58	4.54	4.51

STEEL COLUMNS.—No. 15.

ROUND SECTION.

GREATEST SAFE LOADS IN POUNDS FOR SQUARE INCH OF SECTION.
MEDIUM STEEL.

By this table for the same ratios of $\frac{l}{r}$ the safe loads are increased 10 per cent. over the results obtained for previous tables, as given in table No. 4.

Size of Column.	*Condition of Ends.*	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18
		Greatest Safe Load in Pounds per Square Inch of Section.								
12 ins.	Fixed.	23000	23000	23000	20920	17050	15570	14630	14030	13590
Diameter.	Flat.	23000	23000	23000	20920	17050	15570	14630	14030	13590
$\frac{5}{8}''$ thick.	Hinged.	23000	23000	23000	20140	16390	14810	13810	13090	12580
$R = 4.03$	Round.	23000	23000	23000	18760	15260	13670	12450	11590	10880
10 ins.	Fixed.	23000	23000	22810	17780	15570	14500	13870	13260	12500
Diameter.	Flat.	23000	23000	22810	17780	15570	14500	13870	13260	12500
$\frac{1}{2}''$ thick.	Hinged.	23000	23000	22030	17040	14830	13660	12880	12260	11460
$R = 3.37$	Round.	23000	23000	20950	15780	13690	12280	11340	10470	9580
8 ins.	Fixed.	23000	23000	18600	15490	14250	13550	12570	11690	10900
Diameter.	Flat.	23000	23000	18600	15490	14250	13550	12570	11690	10900
$\frac{1}{2}''$ thick.	Hinged.	23000	23000	17850	14740	13350	12540	11560	10630	9670
$R = 2.66$	Round.	23000	23000	16480	13590	11910	10820	9690	8620	7650
6 ins.	Fixed.	23000	20770	15510	14000	12870	11700	10670	9720	8980
Diameter.	Flat.	23000	20770	15510	14000	12870	11700	10660	9670	8730
$\frac{3}{8}'$ thick.	Hinged.	23000	19990	14760	13060	11880	10650	9390	8190	7200
$R = 2.00$	Round.	23000	18650	13610	11540	10040	8640	7350	6110	5140
5 ins.	Fixed.	23000	17350	14370	13060	11600	10360	9280	8500	7590
Diameter.	Flat.	23000	17350	14370	13060	11600	10340	9180	8070	7050
$\frac{3}{8}''$ thick.	Hinged.	23000	16630	13500	12080	10520	9000	7620	6550	5550
$R = 1.64$	Round.	23000	15430	12090	10270	8500	6940	5550	4510	3560
4 ins.	Fixed.	23000	15490	13550	11690	10170	8970	7940	6830	5910
Diameter.	Flat.	23000	15490	13550	11690	10140	8710	7420	6220	5120
$\frac{1}{4}''$ thick.	Hinged.	23000	14740	12540	10630	8760	7180	5920	4710	3560
$R = 1.33$	Round.	23000	13590	10820	8610	6680	5120	3900	2850	2040
3 ins.	Fixed.	20770	14000	11700	9720	8350	6850	5590	4280	3300
Diameter.	Flat.	20770	14000	11700	9670	7850	6250	4790	3560	2790
$\frac{3}{16}''$ thick.	Hinged.	19990	13060	10650	8190	6350	4740	3250	2230	1620
$R = 1.00$	Round.	18650	11540	8640	6110	4310	2860	1880	1270	910
2 ins.	Fixed.	15450	11640	8920	6780	4810	3230	2290	1760	
Diameter.	Flat.	15450	11640	8650	6150	4040	2730	2020	1450	
$\frac{1}{8}''$ thick.	Hinged.	14700	10570	7120	4640	2580	1580	1090	790	
$R = 0.66$	Round.	13530	8560	5060	2790	1510	890	630	450	

STEEL COLUMNS.—No. 15.

ROUND SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR MEDIUM STEEL.

The calculations are based on the thicknesses and radii of gyration marked under the diameters on marginal columns. See description.

Length in Feet. 20	22	24	26	28	30	32	34	36	*Condition of Ends.*	*Size of Column.*
Greatest Safe Load in Pounds per Square Inch of Section.										
12930	12350	11750	11230	10730	10240	9770	9340	9020	Fixed.	**12** ins.
12930	12350	11750	11230	10710	10220	9730	9260	8800	Flat.	Diameter
11940	11310	10700	10080	9450	8850	8260	7710	7260	Hinged.	⅝″ thick.
10110	9400	8690	8070	7410	6770	6180	5630	5200	Round.	$R = 4.03$
11770	11150	10550	9980	9430	9040	8670	8280	7820	Fixed.	**10** ins.
11770	11150	10540	9950	9370	8830	8290	7780	7290	Flat.	Diameter.
10730	9990	9230	8520	7830	7300	6770	6270	5790	Hinged.	½″ thick.
8720	7960	7180	6450	5750	5230	4730	4240	3780	Round.	$R = 3.37$
10170	9460	8970	8490	7940	7350	6830	6380	5910	Fixed.	**8** ins.
10130	9410	8710	8050	7420	6810	6220	5660	5120	Flat.	Diameter.
8760	7870	7180	6540	5920	5310	4710	4110	3560	Hinged.	½″ thick.
6680	5790	5120	4500	3900	3340	2850	2420	2040	Round.	$R = 2.66$
8350	7570	6850	6250	5590	4910	4280	3760	3300	Fixed.	**6** ins.
7850	7030	6250	5500	4790	4120	3560	3130	2780	Flat.	Diameter.
6350	5530	4740	3940	3250	2640	2230	1910	1620	Hinged.	⅜″ thick.
4310	3540	2860	2300	1880	1550	1270	1060	910	Round.	$R = 2.00$
6730	5990	5160	4350	3720	3180	2800	2430	2110	Fixed.	**5** ins.
6100	5200	4370	3630	3100	2700	2390	2120	1870	Flat.	Diameter.
4580	3630	2860	2280	1880	1550	1320	1160	1000	Hinged.	⅜″ thick.
2750	2080	1670	1300	1050	870	760	670	590	Round.	$R = 1.64$
4880	4000	3280	2790	2330	2010	1790			Fixed.	**4** ins.
4100	3310	2760	2380	2050	1760	1480			Flat.	Diameter.
2620	2050	1610	1320	1110	940	800			Hinged.	¼″ thick.
1540	1150	910	760	650	550	460			Round.	$R = 1.33$
2650	2100	1800							Fixed.	**3** ins.
2280	1860	1490							Flat.	Diameter.
1250	1000	810							Hinged.	$\frac{3}{16}$″ thick.
720	580	460							Round.	$R = 1.00$
									Fixed.	**2** ins.
									Flat.	Diameter.
									Hinged.	⅛″ thick.
									Round.	$R = 0.66$

STEEL COLUMNS.—No. 16.

SQUARE SECTION.

GREATEST SAFE LOADS IN POUNDS FOR SQUARE INCH OF SECTION FOR MEDIUM STEEL.

By this table for the same ratios of $\frac{l}{r}$ the safe loads are increased 5 per cent. over the results obtained for previous tables, as given in table No. 4.

Size of Column.	*Condition of Ends.*	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18
		Greatest safe load in pounds per square inch of section.								
12 ins.	Fixed.	23000	23000	23000	22400	18580	15960	14780	14020	13490
Side.	Flat.	23000	23000	23000	22400	18580	15960	14780	14020	13490
$\frac{5}{8}''$ thick.	Hinged.	23000	23000	23000	21650	17850	15240	14070	13240	12610
$R = 4.65$	Round.	23000	23000	23000	20680	16510	14190	12960	11950	11200
10 ins.	Fixed.	23000	23000	23000	19240	15960	14580	13760	13260	12790
Side.	Flat.	23000	23000	23000	19240	15960	14580	13760	13260	12790
$\frac{1}{2}''$ thick.	Hinged.	23000	23000	23000	18510	15240	13880	12950	12320	11820
$R = 3.87$	Round.	23000	23000	23000	17180	14190	12730	11620	10850	10130
8 ins.	Fixed.	23000	23000	20220	15870	14300	13450	12890	12050	11320
Side.	Flat.	23000	23000	20220	15870	14300	13450	12890	12050	11320
$\frac{1}{2}''$ thick.	Hinged.	23000	23000	19480	15160	13580	12570	11930	11090	10280
$R = 3.07$	Round.	23000	23000	18120	14120	12350	11150	10250	9320	8410
6 ins.	Fixed.	23000	22190	15870	13960	13110	12040	11080	10230	9390
Side.	Flat.	23000	22190	15870	13960	13110	12040	11080	10220	9390
$\frac{3}{8}'$ thick.	Hinged.	23000	21440	15150	13170	12120	11090	10050	9010	8010
$R = 2.30$	Round.	23000	20460	14110	11870	10550	9320	8130	7060	6030
5 ins.	Fixed.	23000	18850	14440	13190	11980	10820	9810	8900	8260
Side.	Flat.	23000	18850	14440	13190	11980	10820	9780	8810	7890
$\frac{3}{8}''$ thick.	Hinged.	23000	18110	13740	12220	11000	9740	8490	7330	6440
$R = 1.89$	Round.	23000	16770	12550	10720	9210	7830	6510	5350	4490
4 ins.	Fixed.	23000	15840	13440	12030	10630	9420	8480	7630	6670
Side.	Flat.	23000	15840	13440	12030	10630	9380	8200	7130	6130
$\frac{1}{4}''$ thick.	Hinged.	23000	15130	12550	11070	9520	7990	6740	5700	4700
$R = 1.53$	Round.	23000	14090	11130	9300	7590	6020	4780	.3780	2860
3 ins.	Fixed.	22190	13960	12040	10230	8760	7650	6440	5390	4270
Side.	Flat.	22190	13960	12040	10220	8610	7150	5840	4630	3580
$\frac{3}{16}''$ thick.	Hinged.	21440	13170	11090	9010	7140	5720	4390	3150	2260
$R = 1.15$	Round.	20470	10870	9320	7060	5160	3790	2640	1830	1300
2 ins.	Fixed.	15910	12060	9460	7680	5970	4320	3080	2300	1800
Side.	Flat.	15910	12060	9420	7190	5260	3610	2600	2020	1530
$\frac{1}{8}''$ thick.	Hinged.	15190	11110	8050	5750	3780	2290	1510	1100	830
$R = 0.77$	Round.	14140	9350	6070	3830	2200	1320	850	630	460

STEEL COLUMNS.—No. 16.

SQUARE SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR MEDIUM STEEL.

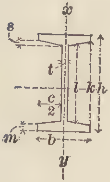
The calculations are based on the thicknesses and radii of gyration marked under the diameters in marginal columns. See previous description.

LENGTH IN FEET.									*Condition of Ends.*	*Size of Column.*
20	22	24	26	28	30	32	34	36		
Greatest safe load in pounds per square inch of section.										
13150	12680	12110	11640	11150	10720	10300	9900	9510	Fixed.	**12** ins.
13150	12680	12110	11640	11150	10720	10290	9880	9470	Flat.	Side.
12160	11720	11160	10650	10140	9620	9100	8600	8110	Hinged.	$\frac{5}{8}''$ thick.
10610	10010	9400	8780	8220	7700	7160	6630	6120	Round.	$R = 4.65$
12090	11550	10970	10450	9970	9500	9040	8700	8390	Fixed.	**10** ins.
12090	11550	10970	10450	9950	9460	8980	8530	8080	Flat.	Side.
11150	10530	9920	9300	8690	8100	7520	7060	6620	Hinged.	$\frac{1}{2}''$ thick.
9380	8660	7990	7360	6720	6110	5530	5080	4660	Round.	$R = 3.87$
10650	10030	9440	8900	8500	8110	7650	7170	6690	Fixed.	**8** ins.
10650	10020	9400	8810	8230	7690	7160	6660	6160	Flat.	Side.
9550	8770	8020	7330	6770	6240	5730	5220	4730	Hinged.	$\frac{1}{2}''$ thick.
7610	6810	6040	5350	4800	4290	3800	3330	2890	Round.	$R = 3.07$
8760	8230	7650	7000	6440	5940	5390	4830	4270	Fixed.	**6** ins.
8610	7860	7150	6480	5830	5220	4630	4070	3580	Flat.	Side.
7140	6410	5720	5050	4390	3730	3160	2650	2260	Hinged.	$\frac{3}{8}''$ thick.
5160	4450	3790	3170	2640	2170	1830	1550	1300	Round.	$R = 2.30$
7540	6750	6130	5500	4800	4140	3620	3150	2810	Fixed.	**5** ins.
7030	6220	5460	4740	4050	3460	3010	2660	2390	Flat.	Side.
5600	4800	3990	3260	2630	2170	1840	1550	1330	Hinged.	$\frac{3}{8}''$ thick.
3680	2940	2350	1880	1540	1240	1030	870	770	Round.	$R = 1.89$
5920	5090	4250	3590	3040	2640	2270	1970	1780	Fixed.	**4** ins.
5200	4330	3560	2990	2570	2260	1990	1740	1500	Flat.	Side.
3710	2880	2240	1820	1480	1250	1080	930	810	Hinged.	$\frac{1}{4}''$ thick.
2150	1680	1290	1020	830	720	620	540	450	Round.	$R = 1.53$
3390	2780	2280	1920	1660					Fixed.	**3** ins.
2840	2370	2000	1670	1370					Flat.	Side.
1700	1320	1090	890	740					Hinged.	$\frac{3}{16}''$ thick.
950	760	630	520	420					Round.	$R = 1.15$
									Fixed.	**2** ins.
									Flat.	Side.
									Hinged.	$\frac{1}{8}''$ thick.
									Round.	$R = 0.77$

MOMENTS OF INERTIA OF STANDARD SECTIONS.

When not otherwise specified, the inertia is the greatest around centre of gravity, or for horizontal axis in figures.

A = total area of section.



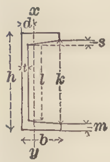
I BEAM SECTION.

s = taper of flange.

$$l = k - \frac{2s}{3}.$$

$$I = \frac{bh^3 - ck^3}{12} + \frac{cs^3}{18} + \frac{csl^2}{4}.$$

$$I, \text{axis } x\,y = \frac{mb^3}{6} + \frac{kt^3}{12} + \frac{s\left(\frac{b-t}{2}\right)^3}{9} + 2\,s\left(\frac{b-t}{2}\right)\left(\frac{b}{6} + \frac{t}{3}\right)^2.$$



CHANNEL SECTION.

s = taper of flange.

$$r = \frac{s}{b-t}.$$

$$I = \frac{bh^3 - \frac{1}{8r}\left(k^4 - l^4\right)}{12}.$$

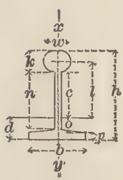
$$I, \text{axis } xy = \frac{2\,mb^3 + lt^3 + \frac{r}{2}\left(b^4 - t^4\right)}{3} - Ad^2.$$

$$d = \frac{mb^2 + \frac{kt^2}{2} + \frac{s}{3}\left(b - t\right)\left(b + 2t\right)}{A}$$

DECK BEAM SECTION.

s = taper of flange. a = area of bulb.

$$o = m - \frac{s}{3}.$$

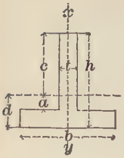


$$I = \frac{4\,\pi\,k^4}{64} + \frac{(w-k)k^3}{12} + al^2 + \frac{tc^3}{3} + \frac{bd^3}{3} - \frac{m^3\,(b-t)}{3} + \frac{(b-t)s^3}{36} + \frac{s\,(b-t)\,o^2}{2}.$$

$$I, \text{axis } xy = \frac{ak^2}{12.4} + \frac{nt^3}{12} + \frac{\left(p + \frac{s}{4}\right)b^3}{12}$$

$$d = \frac{a\,(2\,h - k) + t\,(h-k)^2 + (b-t)\,p^2 + s\,(b-t)\left(p + \frac{s}{3}\right)}{2A}.$$

Tee Section.

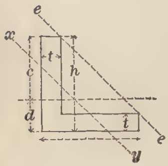


$$I = \frac{tc^3 + bd^3 - (b - t)\,a^3}{3}.$$

$$I, \text{ axis } xy = \frac{fb^3 + (h - f)\,t^3}{12}.$$

$$d = \frac{bf^2 + t\,(h^2 - f^2)}{2A}.$$

Angle Section.



$$I = \frac{tc^3 + bd^3 - (b - t)\,(d - t)^3}{3}.$$ For even or uneven angles.

$$I, \text{ axis } uv = \frac{t\,(b - d_1)^3 + hd_1^3 - (h - t)\,(d_1 - t)^3}{3}.$$

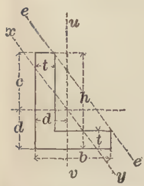
For uneven angles.

---

xy passes through centre of gravity parallel to ee.

$$I \text{ axis } xy = \frac{2d^4 - 2\,(d-t)^4 + t\left[b - \left(2d - \frac{t}{2}\right)\right]^3}{3}.$$ For even angles.

A close approximation for the latter is the following:



$$I, \text{ axis } xy = \frac{Ab^2}{25}.$$ For even angles.

$$I, \text{ axis } xy = \frac{Ah^2b^2}{13\,(h^2 + b^2)}.$$ For uneven angles.

A close approximation for I, axis xy is

$$I, \text{ axis } xy = \frac{o^2 + c^2}{B\,(o^2 + c^2)} \times A$$

in which o = long leg; c = short leg; A = area of angle; B is a constant which will vary with the ratio of length of legs as follows:

Even Legs $B = 12.75$.

Ratio of Legs $1 : 1\frac{1}{3}$ $B = 12.9$. Ratio of Legs $1 : 1\frac{2}{3}$ $B = 13.4$

Ratio of Legs $1 : 1\frac{1}{2}$ $B = 13.1$. Ratio of Legs $1 : 2$ $B = 13.7$

$$d = \frac{bt^2 + t\,(h^2 - t^2)}{2A}.$$ For even and uneven angles.

$$d' = \frac{ht^2 + t\,(b^2 - t^2)}{2A}.\quad \text{For uneven angles.}$$

In uneven angles the distance from centre of gravity in direction of the long leg exceeds that in the direction of the short leg by half the difference in the length of the two legs.

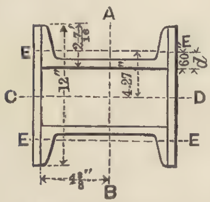
In angles and tees of equal legs and thickness

$$d = \tfrac{1}{4}\left(b + \frac{3}{2}\,t\right) \text{ nearly.}$$

Inertia of Compound Shapes.

"The moment of inertia of any section about any axis is equal to the I about a parallel axis passing through its centre of gravity + the area of the section multiplied by the square of the distance between the axes."

By use of this rule, the moments of inertia or radii of gyration of any single sections being known, corresponding values can readily be obtained for any combination of these sections.



Example No. 1.—A combination of two 9″ channels of 3.89 square inches section, and two 12 × ¼ plates as shown.

Axis A B of Section.

I for two channels, col. V, page 192,		= 95.78
I for two plates $= \dfrac{12 \times .25^3}{12} \times 2 = .03125$		
6 (area of plates) $\times 4\frac{5}{8}{}^2$ $= 128.34375$		= 128.375
I for combined section		= 224.155

which divided by area (13.78) gives $16.27 = R^2$ or 4.03 radius of combined section.

Axis C D.

Find distance $d = (.60)$ from page 193, then obtaining the distance (4.17) between axes $C\,D$ and $E\,F$.

I for two channels around axis EF from col. VI, $=$ 3.54

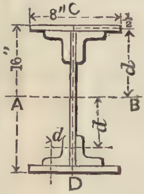
Area of channels $\times$ sq. of dist. $= 7.78 \times 4.17^2 =$ 135.286

I for two plates $= \dfrac{.5 \times 12^3}{12}$ $=$ 72.

I for combined section $=$ 210.826

Radius of gyration $= \sqrt{\dfrac{210.826}{13.78}} = 3.91$

By similar methods, inertia or radius of gyration for any combination of shapes can readily be obtained.



Example No. 2.—A "built-up beam" composed of: 4 angles $3'' \times 3'' \times \frac{1}{4}''$.
2 plates $8'' \times \frac{1}{2}''$.
1 plate $15'' \times \frac{3}{8}''$.

Axis A B.

I of two $8'' \times \frac{1}{2}$ plates $= \dfrac{8 \times \frac{1}{2}^3}{12} \times 2 =$ .167

$+ 8$ (area) $\times 7\frac{3}{4}^2$ (sq. of distance d) $=$ 480.5

480.667

I of one $15'' \times \frac{3}{8}$ plate $= \dfrac{15^3 \times \frac{3}{8}}{12} =$ 105.469

I of four $3 \times 3 \times \frac{1}{4}$ angles $= 4 \times 1.25 =$ 5 00

$+ 5.76$ (area) $\times 6.66^2$ (sq. of distance d^1) $=$ 255.488

260.488

Inertia of combined section around $A\ B =$ 846.624

Radius of gyration $= \sqrt{\dfrac{846.624}{19.385}} = 6.61$

Radius of Gyration of Compound Shapes.

In the case of a pair of any shape without a web the value of R can always be readily found without considering the moment of inertia.

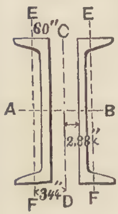
The radius of gyration for any section around an axis parallel to another axis passing through its centre of gravity is found as follows:

Let r = radius of gyration around axis through centre of gravity. R = radius of gyration around another axis parallel to above. d = distance between axis.

$$R = \sqrt{d^2 + r^2}.$$

When r is small, R may be taken as equal to d without material error. Thus, in the case of a pair of channels latticed together, or a similar construction.

Example No. 1.—Two 9″ channels of 3.89 square inches section placed 5.68″ apart, required the radius of gyration around axis $C\ D$ for combined section.



Find in col. X, page 192, $r = .67$ and $r^2 = 0.45$.

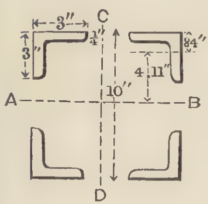
Find distance from base of channel to neutral axis, same page, = .60, this added to one half the distance between the two bars, 2.84″ = 3.44″ d, and $d^2 = 11.8336$.

Radius of gyration of the pair as placed =

$$\sqrt{11.8336 + 0.45} = 3.505$$

The value of R for the whole section in relation to the axis $A\ B$ is the same as for the single channel, to be found in the tables.

Example No. 2.—Four 3″ × 3″ × ¼″ angles placed as shown, form a column of 10 inches square; required the radius of gyration.



Find in column VIII, page 207, $r = .93$ and $r^2 = .8649$.

Find distance from side of angle to neutral axis, same page, = .84. Subtract this from half the width of column = 5. — .84 = 4.16 = d or distance between two axes. $d^2 = 17.3056$.

Radius of gyration of four angles as placed =

$$\sqrt{17.3056 + .8649} = 4.26.$$

When the angles are large as compared with the outer dimensions of the combined section, the radius of gyration can be taken without serious error from the table of radii of gyration for square columns, on page 177.

ELEMENTS OF PENCOYD STRUCTURAL SHAPES.

In the following tables various fundamental properties of rolled sections are given, whereby the strength or stiffness of each can be readily determined.

The calculations are made for all sections of **I** beams and channels, and for the least and greatest thickness of other shapes; intermediate thicknesses of these can be approximated by interpolation.

Moments of Inertia for the sections are obtained as hereafter described.

Radius of Gyration equals $\sqrt{\frac{\text{Inertia}}{\text{area}}}$, is used for determining the resistance of struts or columns.

Moment of Resistance equals $\frac{\text{Inertia}}{\text{distance from axis to extreme fibres}}$ is used for determining transverse strength in beams, etc., as described on page 116.

Coefficent for Safe Load is the calculated load in net tons, on a beam one foot between supports, that produces fibre strains of 16,000 lbs. per square inch. A corresponding load for any beam is found by dividing this coefficient by the length of span in feet.

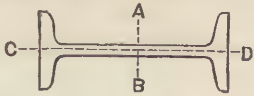
Coefficients for Deflection are found by the formulæ on page 220, based on a modulus of elasticity of 28,000,000 lbs. They apply to beams one foot long, bearing one ton (2,000 lbs.) The deflection of any beam in inches is found by multiplying its coefficient by the load in net tons and by the cube of the length in feet.

Maximum Load in Net Tons indicates the greatest load that a beam, however short, should carry, unless its web is reinforced, to prevent crippling. This load is obtained by the formula:

$$W = \frac{xdt}{1 + \frac{l^2}{3000t^2}}$$

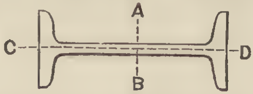
$x = 8$ tons.
$d =$ depth of beam.
$t =$ thickness of web.
$l = d \times$ secant $45°$ $(l^2 = 2d^2)$.

ELEMENTS OF PENCOYD BEAMS.



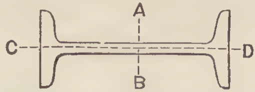
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Size in Inches.	*Section Number.*	*Area in Square Inches.*	*Weight per Foot in Pounds.*	*Moments of Inertia.*		*Square of Radius of Gyration.*	
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*
24	240B	23.53	80	2111.40	42.84	89.73	1.82
24	241B	24.99	85	2181.67	44.14	87.30	1.77
24	242B	26.47	90	2356.76	54.38	89.07	2.06
24	243B	27.92	95	2427.03	55.93	86.93	2.00
24	244B	29 42	100	2497.30	57.53	84.88	1.96
20	200B	19.10	65	1179.71	27.72	61.76	1.45
20	201B	20.58	70	1229.04	28.87	59.72	1.40
20	202B	22.04	75	1277.71	30.05	57.97	1.36
20	203B	23.53	80	1404.39	38.84	59.69	1.65
20	204B	25.01	85	1453.06	40.33	58.10	1.61
20	205B	26.47	90	1501.73	41.88	56.73	1.58
20	206B	27.95	95	1601.86	53.63	57.31	1.92
20	207B	29.42	100	1649.55	55.57	56.07	1.89
18	180B	16.13	55	809.05	21.17	50.16	1.31
18	181B	17.64	60	849.88	22.22	48.18	1.26
18	182B	19.12	65	889.73	23.30	46.53	1.22
18	183B	20.59	70	981.72	30.23	47 68	1.47
18	184B	22.05	75	1023.52	31.67	46.42	1.44
18	185B	23.53	80	1063.37	33.12	45.19	1.41
18	186B	25.00	85	1149.62	44.18	45.98	1.77
18	187B	26.46	90	1187.99	46.03	44.90	1.74
15	150B	12.35	42	443.71	14.43	35.93	1.17
15	151B	13.23	45	460.30	14.97	34.79	1.13
15	152B	14.70	50	515.22	19.20	35.05	1.31
15	153B	16.17	55	542.84	20.34	33.57	1.26
15	154B	17.64	60	619.02	27.60	35.09	1.56
15	155B	19.11	65	646.58	29.13	33.83	1.52
15	156B	20.60	70	718.71	36.73	34.89	1.78
15	157B	22.05	75	745.99	38.64	33.83	1.75
15	158B	23.54	80	773.84	40.69	32.87	1.73
12	120B	9.27	31.5	218.71	9.45	23.59	1.02
12	121B	10.29	35.0	230.95	10.01	22.44	0.97
12	122B	11.77	40.0	274.68	14.26	23.34	1.21
12	123B	13.23	45.0	292.25	15.41	22.09	1.16
12	124B	14.70	50.0	332.08	20.79	22.59	1.41
12	125B	16.17	55.0	368.06	25.12	22.76	1.55
12	126B	17.64	60.0	385.77	26.96	21.87	1.53
12	127B	19.12	65.0	403.48	28.93	21.10	1.51

ELEMENTS OF PENCOYD BEAMS.



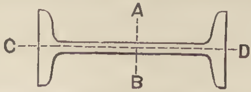
IX.	X.	XI.	XII.	XIII.	XIV.	XV.	IV.	I.
Radius of Gyration.		*Resistance.*	*Coef. for Greatest Safe Load in Net Tons.*	*Coefficient for Deflection.*		*Max. Load in Net Tons.*	*Weight per Foot in Lbs.*	*Size in In.*
Axis A. B.	*Axis C. D.*	*Axis A. B.*		*Distributed Load.*	*Center Load.*			
9.47	1.35	176.0	938.4	.00000076	.00000122	37.9	80.0	24
9.34	1.33	181.8	969.6	.00000073	.00000117	48.5	85.0	24
9.44	1.44	196.4	1047.4	.00000068	.00000109	48.3	90.0	24
9.32	1.41	202.3	1078.7	.00000066	.00000106	59.7	95.0	24
9.21	1.40	208.1	1109.9	.00000064	.00000103	71.7	100.0	24
7.86	1.20	118.0	629.2	.00000137	.00000217	37.1	65.0	20
7.73	1.18	122.9	655.5	.00000130	.00000209	49.1	70.0	20
7.61	1.17	127.8	681.5	.00000125	.00000200	61.5	75.0	20
7.73	1.28	140.4	749.0	.00000114	.00000183	60.3	80.0	20
7.62	1.27	145.3	775.0	.00000110	.00000176	73.1	85.0	20
7.53	1.26	150.2	800.9	.00000106	.00000171	86.8	90.0	20
7.57	1.39	160.2	864.1	.00000100	.00000160	79.3	95.0	20
7.49	1.37	165.0	889.8	.00000097	.00000155	92.4	100.0	20
7.08	1.14	89.9	479.4	.00000198	.00000317	32.8	55.0	18
6.94	1.12	94.4	503.6	.00000188	.00000302	45.3	60.0	18
6.82	1.10	98.9	527.3	.00000180	.00000288	58.1	65.0	18
6.91	1.21	109.1	581.8	.00000162	.00000261	57.2	70.0	18
6.81	1.20	113.7	606.5	.00000156	.00000250	70.9	75.0	18
6.72	1.19	118.2	630.2	.00000150	.00000241	84.2	80.0	18
6.78	1.33	127.7	689.9	.00000139	.00000223	76.0	85.0	18
6.70	1.32	132.0	712.9	.00000135	.00000216	89.1	90.0	18
5.99	1.08	59.2	315.5	.00000357	.00000578	23.8	42.0	15
5.90	1.06	61.4	327.3	.00000348	.00000557	31.2	45.0	15
5.92	1.14	68.7	366.4	.00000311	.00000498	35.1	50.0	15
5.79	1.12	72.4	386.0	.00000295	.00000472	48.1	55.0	15
5.92	1.25	82.5	440.2	.00000258	.00000414	44.7	60.0	15
5.82	1.23	86.2	459.8	.00000247	.00000397	57.8	65.0	15
5.91	1.33	95.8	511.1	.00000223	.00000357	54.9	70.0	15
5.82	1.32	99.5	530.5	.00000214	.00000344	68.0	75.0	15
5.73	1.32	103.2	550.3	.00000207	.00000331	81.3	80.0	15
4.86	1.01	36.5	194.4	.00000727	.00001172	17.8	31.5	12
4.74	0.99	38.5	205.3	.00000693	.00001110	26.6	35.0	12
4.83	1.10	45.8	244.2	.00000582	.00000933	26.1	40.0	12
4.70	1.08	48.7	259.8	.00000547	.00000877	39.2	45.0	12
4.75	1.19	55.4	295.2	.00000482	.00000772	40.1	50.0	12
4.77	1.25	61.3	327.2	.00000435	.00000697	40.9	55.0	12
4.68	1.24	64.3	342.9	.00000415	.00000665	54.2	60.0	12
4.59	1.23	67.3	358.7	.00000397	.00000635	67.2	65.0	12

ELEMENTS OF PENCOYD BEAMS.



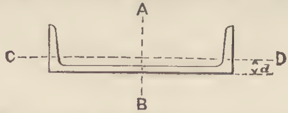
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
				Moments of Inertia.		*Square of Radius of Gyration.*	
Size in Inches.	*Section Number.*	*Area in Square Inches.*	*Weight per Foot in Lbs.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*
10	100B	7.34	25.00	123.07	6.81	16.77	0.93
10	101B	8.82	30.00	135.41	7.58	15.35	0.86
10	102B	10.27	35.00	163.14	11.19	15.89	1.09
10	103B	11.75	40.00	175.48	12.36	14.93	1.05
9	90B	6.17	21.00	84.94	5.06	13.77	0.82
9	91B	7.34	25.00	92.83	5.60	12.65	0.76
9	92B	8.82	30.00	102.80	6.37	11.66	0.72
9	93B	10.30	35.00	112.76	7.25	10.95	0.70
8	80B	5.29	18.00	57.36	3.72	10.84	0.70
8	81B	6.03	20.50	61.29	4.02	10.16	0.67
8	82B	6.77	23.00	65.21	4.35	9.63	0.64
8	83B	7.50	25.50	69.14	4.70	9.22	0.63
7	70B	4.42	15.00	36.61	2.64	8.28	0.60
7	71B	5.15	17.50	39.58	2.90	7.69	0.56
7	72B	5.88	20.00	42.55	3.20	7.24	0.54
6	60B	3.60	12.25	22.09	1.83	6.14	0.51
6	61B	4.34	14.75	24.28	2.06	5.59	0.48
6	62B	5.07	17.25	26.50	2.34	5.23	0.46
6	63B	9.49	32.30	51.79	11.66	5.46	1.23
		to	to				
6	63B	10.99	37.40	56.29	13.78	5.12	1.25
6	67B	12.06	41.00	63.87	18.23	5.30	1.51
		to	to				
6	67B	13.56	46.10	68.37	21.22	5.04	1.56
5	50B	2.87	9.75	12.12	1.21	4.22	0.42
5	51B	3.60	12.25	13.66	1.42	3.79	0.40
5	52B	4.34	14.75	15.18	1.67	3.50	0.39
4	40B	2.20	7.50	5.90	0.76	2.68	0.34
4	41B	2.50	8.50	6.29	0.83	2.52	0.33
4	42B	2.79	9.50	6.68	0.91	2.39	0.33
4	43B	3.08	10.50	7.07	1.00	2.30	0.32
3	30B	1.62	5.50	2.43	0.45	1.50	0.28
3	31B	1.91	6.50	2.64	0.51	1.38	0.27
3	32B	2.20	7.50	2.87	0.59	1.30	0.27

ELEMENTS OF PENCOYD BEAMS.



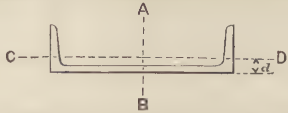
IX.	X.	XI.	XII.	XIII.	XIV.	XV.	IV.	I.
Radius of Gyration.		*Resistance.*	*Coef. for Greatest Safe Load in Net Tons.*	*Coefficient for Deflection.*		*Max. Load in Net Tons.*	*Weight per Foot in Lbs.*	*Size in Ins.*
Axis A. B.	*Axis C. D.*	*Axis A. B.*		*Distributed Load.*	*Center Load.*			
4.10	0.96	24.6	131.3	.0000129	.0000208	13.5	25.00	10
3.92	0.93	27.1	144.4	.0000118	.0000189	26.6	30.00	10
3.99	1.04	32.6	174.0	.0000098	.0000158	26.2	35.00	10
3.86	1.03	35.1	187.2	.0000091	.0000146	39.4	40.00	10
3.71	0.91	18.9	100.7	.0000185	.0000302	10.6	21.00	9
3.56	0.87	20.6	110.0	.0000172	.0000276	20.9	25.00	9
3.41	0.85	22.8	121.8	.0000156	.0000249	34.1	30.00	9
3.31	0.84	25.1	133.6	.0000142	.0000227	46.9	35.00	9
3.29	0.84	14.3	76.5	.0000275	.0000447	9.7	18.00	8
3.19	0.82	15.3	81.7	.0000261	.0000418	16.3	20.50	8
3.10	0.80	16.3	87.0	.0000245	.0000393	22.9	23.00	8
3.04	0.79	17.3	92.2	.0000231	.0000371	29.4	25.50	8
2.88	0.78	10.5	55.8	.0000433	.0000700	8.6	15.00	7
2.77	0.75	11.3	60.3	.0000404	.0000648	15.1	17.50	7
2.69	0.74	12.2	64.8	.0000376	.0000603	21.6	20.00	7
2.48	0.71	7.4	39.3	.0000717	.0001161	6.9	12.25	6
2.36	0.69	8.1	43.2	.0000659	.0001056	13.5	14.75	6
2.29	0.68	8.8	47.1	.0000604	.0000968	19.9	17.25	6
2.34	1.11	17.3	92.1	.0000310	.0000495	21.9	32.30	6
2.26	1.12	18.8	100.1	.0000286	.0000456	34.6	to 37.40	6
2.30	1.23	21.3	113.6	.0000251	.0000401	28.5	41.00	6
2.25	1.25	22.8	121.6	.0000235	.0000375	40.7	to 46.10	6
2.05	0.65	4.9	25.9	.0001305	.0002115	5.5	9.75	5
1.95	0.63	5.5	29.1	.0001171	.0001877	12.1	12.25	5
1.87	0.62	6.1	32.4	.0001054	.0001689	18.4	14.75	5
1.64	0.58	3.0	15.7	.0002671	.0004346	4.1	7.50	4
1.59	0.57	3.2	16.8	.0002544	.0004076	6.7	8.50	4
1.55	0.57	3.3	17.8	.0002395	.0003838	9.2	9.50	4
1.52	0.57	3.5	18.9	.0002263	.0003627	11.7	10.50	4
1.23	0.53	1.6	8.6	.0006452	.0010552	2.7	5.50	3
1.17	0.52	1.8	9.4	.0006061	.0009713	5.3	6.50	3
1.14	0.52	1.9	10.2	.0005575	.0008934	7.8	7.50	3

ELEMENTS OF PENCOYD CHANNELS.



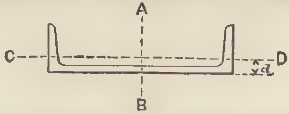
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X
Size in Ins.	Section No.	Area in Square Inches.	Weight per Foot in Lbs.	Moments of Inertia.		Square of Rad. of Gyration.		Radius of Gyration.	
				Axis A. B.	Axis C. D.	Axis A. B.	Axis C. D.	Axis A. B.	Axis C. D.
15	150C	9.69	33.0	311.21	8.10	32.12	0.84	5.67	0.91
15	151C	10.29	35.0	322.46	8.48	31.34	0.82	5.60	0.91
15	152C	11.76	40.0	350.02	9.38	29.76	0.80	5.46	0.89
15	153C	13.23	45.0	377.59	10.29	28.54	0.78	5.34	0.88
15	154C	14.70	50.0	442.29	15.87	30.09	1.08	5.49	1.04
15	155C	16.17	55.0	469.85	17.20	29.06	1.06	5.39	1.03
12	120C	6.02	20.5	129.27	3.90	21.47	0.65	4.63	0.81
12	121C	7.34	25.0	145.11	4.53	19.77	0.62	4.45	0.79
12	122C	8.82	30.0	162.83	5.20	18.46	0.59	4.30	0.77
12	123C	10.30	35.0	207.68	9.32	20.16	0.91	4.49	0.95
12	124C	11.76	40.0	225.25	10.49	19.15	0.89	4.38	0.95
12	128C	6.01	20.5	123.98	3.10	20.63	0.52	4.54	0.72
		to	to						
12	128C	9.40	32.0	164.30	4.42	17.48	0.47	4.18	0.69
10	100C	4.41	15.0	67.11	2.28	15.22	0.52	3.90	0.72
10	101C	5.88	20.0	79.36	2.84	13.50	0.48	3.67	0.70
10	102C	7.36	25.0	100.11	4.39	13.60	0.60	3.69	0.77
10	103C	8.83	30.0	112.36	5.16	12.72	0.58	3.57	0.77
10	104C	10.29	35.0	124.61	5.99	12.11	0.58	3.48	0.76
9	90C	3.89	13.25	47.89	1.77	12.31	0.45	3.51	0.67
9	91C	4.41	15.00	51.35	1.95	11.64	0.44	3.41	0.67
9	92C	5.88	20.00	66.97	3.19	11.39	0.54	3.38	0.74
9	93C	7.35	25.00	76.93	3.89	10.47	0.53	3.24	0.73
8	80C	3.31	11.25	32.51	1.32	9.82	0.40	3.13	0.63
8	81C	4.04	13.75	36.43	1.55	9.02	0.38	3.00	0.62
8	82C	4.78	16.25	44.00	2.33	9.21	0.49	3.03	0.70
8	83C	5.51	18.75	47.93	2.65	8.70	0.48	2.95	0.69
8	84C	6.25	21.25	51.85	2·97	8.30	0.48	2.88	0.69

ELEMENTS OF PENCOYD CHANNELS.



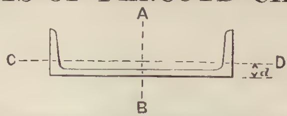
XI.	XII.	XIII.	XIV.	XV.	XVI.	I.
Distance "d" from Base to Neutral Axis.	*Resistance.*	*Coef. for Greatest Safe Load in Net Tons.*	*Coefficient for Deflection.*		*Max. Load in Net Tons.*	*Size in Ins.*
	Axis A. B.		*Distributed Load.*	*Center Load.*		
0.79	41.5	221.3	.00000514	.00000826	22.5	15
0.78	43.0	229.3	.00000496	.00000796	27.4	15
0.78	46.7	248.9	.00000457	.00000734	40.0	15
0.78	50.4	268.5	.00000424	.00000681	53.1	15
0.94	59.0	314.5	.00000362	.00000581	54.5	15
0.95	62.7	334.1	.00000340	.00000546	67.7	15
0.70	21.6	114.9	.00001237	.00001986	11.7	12
0.67	24.2	129.0	.00001103	.00001771	22 5	12
0.67	27.1	144.7	.00000983	.00001578	35.7	12
0.89	34.6	184.6	.00000770	.00001236	34.7	12
0.89	37.5	200.2	.00000710	.00001140	47.8	12
0.62	20.7	110.2	.00001290	.00002072	12.1	12
0.62	27.4	146.0	.00000974	.00001564	41.2	12
0.64	13.4	71.6	.00002384	.00003838	8.2	10
0.60	15.9	84.7	.00002016	.00003246	20.6	10
0.71	20.0	106.8	.00001598	.00002573	27.4	10
0.73	22.5	119.9	.00001424	.00002293	40.5	10
0.76	24.9	132.9	.00001284	.00002067	53.4	10
0.60	10.6	56.8	.00003341	.00005379	7.8	9
0.59	11.4	60.9	.00003116	.00005017	12.1	9
0.68	14.9	79.4	.00002389	.00003846	19.8	9
0.69	17.1	91.2	.00002080	.00003349	33.1	9
0.57	8.1	43.4	.00004921	.00007923	6.8	8
0.55	9.1	48.6	.00004392	.00007071	13.2	8
0.65	11.0	58.7	.00003636	.00005854	15.4	8
0.65	12.0	63.9	.00003338	.00005374	22.0	8
0.66	13.0	69.1	.00003086	.00004968	28.5	8

ELEMENTS OF PENCOYD CHANNELS.



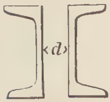
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Size in Ins.	Section No.	Area in Square Inches.	Weight per Foot in Lbs.	Moments of Inertia.		Square of Rad. of Gyration.		Radius of Gyration.	
				Axis A. B.	Axis C. D.	Axis A. B.	Axis C. D.	Axis A. B.	Axis C. D.
7	70C	2.86	9.75	21.37	0.98	7.47	0.34	2.73	0.59
7	71C	3.60	12.25	24.37	1.19	6.77	0.33	2.60	0.58
7	72C	4.34	14.75	29.85	1.89	6.88	0.44	2.62	0.66
7	73C	5.07	17.25	32.85	2.18	6.48	0.43	2.55	0.66
7	74C	5.81	19.75	35.85	2.49	6.17	0.43	2.48	0.66
6	60C	2.35	8.00	13.07	0.69	5.56	0.29	2.36	0.54
6	61C	3.09	10.50	16.23	1.08	5.25	0.35	2.29	0.59
6	62C	3.82	13.00	18.43	1.32	4.83	0.35	2.20	0.59
6	63C	4.56	15.50	20.64	1.57	4.53	0.34	2.13	0.59
5	50C	1.91	6.50	7.37	0.47	3.86	0.25	1.96	0.50
5	51C	2.64	9.00	8.90	0.64	3.37	0.24	1.84	0.49
5	52C	3.38	11.50	10.43	0.82	3.09	0.24	1.76	0.49
4	40C	1.54	5.25	3.74	0.32	2.43	0.21	1.56	0.45
4	41C	1.84	6.25	4.13	0.38	2.24	0.21	1.50	0.45
4	42C	2.13	7.25	4.52	0.44	2.12	0.21	1.46	0.46
3	30C	1.18	4.00	1.61	0.20	1.36	0.17	1.17	0.41
3	31C	1.47	5.00	1.83	0.25	1.24	0.17	1.11	0.42
3	32C	1.76	6.00	2.05	0.31	1.16	0.18	1.07	0.42
2¼	22C	1.12	3.80	0.80	0.19	0.71	0.17	0.85	0.42
2	20C	0.87	2.90	0.48	0.08	0.55	0.10	0.74	0.31
2	20C	1.06	3.60	0.54	0.11	0.51	0.10	0.71	0.32
1¾	17C	0.33	1.13	0.15	0.01	0.46	0.03	0.67	0.16

ELEMENTS OF PENCOYD CHANNELS.

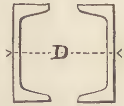


XI.	XII.	XIII.	XIV.	XV.	XVI.	I.
Distance "d" from Base to Neutral Axis.	*Resistance.* *Axis A. B.*	*Coef. for Greatest Safe Load in Net Tons.*	*Coefficient for Deflection.* *Distributed Load.*	*Centre Load.*	*Maxim. Load in Net Töns.*	*Size in Inches.*
0.54	6.1	32 6	.00007487	.00012054	6.6	7
0.52	7.0	37.1	.00006565	.00010570	13.2	7
0.62	8.5	45.5	.00005360	.00008630	16.0	7
0.63	9.4	50.1	.00004870	.00007841	22.6	7
0.65	10.2	54.6	.00004463	.00007185	28.9	7
0 51	4.4	23.2	.00012242	.00019709	5.4	6
0.56	5.4	28.9	.00009858	.00015871	10.0	6
0.57	6.1	32.8	.00008681	.00013976	16.5	6
0.59	6.9	36.7	.00007752	.00012481	22.9	6
0.49	3.0	15.7	.00021710	.00034953	4.6	5
0.48	3.6	19.0	.00017977	.00028943	11.1	5
0.50	4.2	22.3	.00015340	.00024697	10.7	5
0.46	1.9	10.0	.00042781	.00068877	4.1	4
0.45	2.1	11.0	.00038741	.00062373	6.7	4
0.46	2.3	12.1	.00035398	.00056991	9.2	4
0.43	1.1	5.7	.00099377	.00159997	3.0	3
0.43	1.2	6.5	.00087432	.00140765	5.5	3
0.45	1.4	7.3	.00078050	.00125660	8.0	3
0.47	0.7	3.8	.00200000	.00322000	4.3	2¼
0.36	0.5	2.6	.00333333	.00536666	3.3	2
0.37	0.5	2.9	.00296980	.00478138	4.8	2
0.18	0.2	0.9	.01066672	.01717342	1.0	1¾

SEPARATION OF CHANNELS IN LATTICED STRUTS.



Tabulated distances "*d*" and "*D*" make radii of gyration the same for both axes.

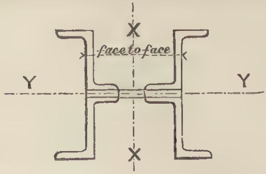


Section Number.	*Size in Inches.*	*For a Single Channel.* *Wt. per Ft. in Lbs.*	*Area in Sq. Inches.*	*"d" in Inches.*	*"D" in Inches.*
150C	15	33.0	9.69	9.59	12.75
151C	15	35.0	10.29	9.49	12.61
152C	15	40.0	11.76	9.20	12.32
153C	15	45.0	13.23	8.98	12.10
154C	15	50.0	14.70	8.89	12.65
155C	15	55.0	16.17	8.68	12.48
120C	12	20.5	6.02	7.73	10.52
121C	12	25.0	7.34	7.41	10.09
122C	12	30.0	8.82	7.11	9.79
123C	12	35.0	10.30	6.99	10.56
124C	12	40.0	11.76	6.76	10.33
128C	12	20.5	6.01	7.73	10.21
128C	12	32.0	9.40	7.00	9.49
100C	10	15.0	4.41	6.39	8.95
101C	10	20.0	5.88	6.01	8.42
102C	10	25.0	7.36	5.81	8.65
103C	10	30.0	8.83	5.51	8.43
104C	10	35.0	10.29	5.27	8.31
90C	9	13.25	3.89	5.68	8.08
91C	9	15.00	4.41	5.52	7.88
92C	9	20.00	5.88	5.23	7.95
93C	9	25.00	7.35	4.92	7.68
80C	8	11.25	3.31	5.00	7.28
81C	8	13.75	4.04	4.78	6.98
82C	8	16.25	4.78	4.60	7.20
83C	8	18.75	5.51	4.43	7.03
84C	8	21.25	6.25	4.27	6.91

Section Number.	*Size in Inches.*	*For a Single Channel.* *Wt. per Ft. in Lbs.*	*Area in Sq. Inches.*	*"d" in Inches.*	*"D" in Inches.*
70C	7	9.75	2.86	4.26	6.42
71C	7	12.25	3.60	4.03	6.11
72C	7	14.75	4.34	3.83	6.32
73C	7	17.25	5.07	3.66	6.18
74C	7	19.75	5.81	3.49	6.09
60C	6	8.00	2.35	3.58	5.62
61C	6	10.50	3.09	3.31	5.55
62C	6	13.00	3.82	3.09	5.37
63C	6	15.50	4.56	2.91	5.27
50C	5	6.50	1.91	2.82	4.78
51C	5	9.00	2.64	2.58	4.50
52C	5	11.50	3.38	2.37	4.37
40C	4	5.25	1.54	2.06	3.90
41C	4	6.25	1.84	1.96	3.76
42C	4	7.25	2.13	1.85	3.70
30C	3	4.00	1.18	1.32	3.05
31C	3	5.00	1.47	1.21	2.93
32C	3	6.00	1.76	1.09	2.89
22C	$2\frac{1}{4}$	3.80	1.12	0.54	2.42
20C	2	2.90	0.87	0.64	2 08
20C	2	3.60	1.06	0.54	2.02
17C	$1\frac{3}{4}$	1.13	0.33	0.94	1.66

ELEMENTS OF Z BAR COLUMNS.

I = Mom. of Inertia.

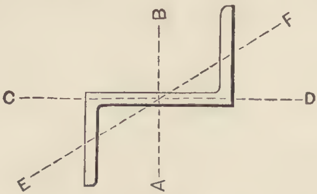


R = Rad. of Gyration.

THE THICKNESSES OF WEB PLATE AND Z BARS ARE THE SAME.

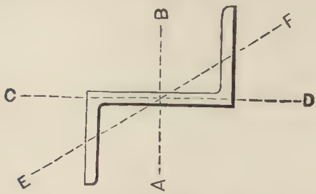
Size of Z Bar in Inches.	Area of 4 Z Bars and 1 Plate.	Axis XX.		Axis YY.		Area of 4 Z Bars and 1 Plate.	Axis XX.		Axis YY.	
		I.	*R.*	*I.*	*R.*		*I.*	*R.*	*I.*	*R.*
	7″ Web Plate. 7¼″ Face to Face.					*8″ Web Plate. 8¼″ Face to Face.*				
$3\frac{1}{2}$ x6 x$3\frac{1}{2}$ x$\frac{3}{8}$	20.99	264.11	3.55	287.85	3.70	21.36	337.09	3.97	287.86	3.67
$3\frac{9}{16}$x$6\frac{1}{16}$x$3\frac{9}{16}$x$\frac{7}{16}$	24.62	306.46	3.53	346.98	3.75	25.06	391.45	3.95	346.99	3.72
$3\frac{5}{8}$ x$6\frac{1}{8}$ x$3\frac{5}{8}$ x$\frac{1}{2}$	28.26	347.80	3.51	409.27	3.80	28.76	444.60	3.93	409.29	3.77
$3\frac{1}{2}$ x6 x$3\frac{1}{2}$ x$\frac{9}{16}$	30.66	365.19	3.45	426.34	3.73	31.22	469.13	3.88	426.36	3.69
$3\frac{9}{16}$x$6\frac{1}{16}$x$3\frac{9}{16}$ x$\frac{5}{8}$	34.22	402.96	3.43	489.21	3.78	34.84	518,08	3.86	489.23	3.75
$3\frac{5}{8}$ x$6\frac{1}{8}$ x$3\frac{5}{8}$ x$\frac{11}{16}$	37.81	440.31	3.41	555.79	3.83	38.50	566.52	3.83	555.82	3.80
$3\frac{1}{2}$ x6 x$3\frac{1}{2}$ x $\frac{3}{4}$	39.81	448.24	3.36	562.39	3.76	40.56	579.76	3.78	562.43	3.72
$3\frac{9}{16}$x$6\frac{1}{16}$x$3\frac{9}{16}$x$\frac{13}{16}$	43.21	481.03	3.34	628.18	3.81	44.02	622.55	3.76	628.23	3.78
$3\frac{5}{8}$ x$6\frac{1}{8}$ x$3\frac{5}{8}$ x $\frac{7}{8}$	46.77	514.64	3.32	699.11	3.87	47.64	666.66	3.74	699.17	3.83
	7″ Web Plate. 7¾″ Face to Face.					*8″ Web Plate. 8¼″ Face to Face.*				
$3\frac{3}{16}$x5 x$3\frac{3}{16}$x$\frac{5}{16}$	15.63	193.88	3.52	147.41	3.07	15.94	248.26	3.95	147.41	3.04
$3\frac{1}{4}$ x$5\frac{1}{16}$x$3\frac{1}{4}$ x $\frac{3}{8}$	18.83	231.00	3.50	183.49	3.12	19.20	295.96	3.92	183.50	3.09
$3\frac{5}{16}$x$5\frac{1}{8}$ x$3\frac{5}{16}$x$\frac{7}{16}$	22.06	267.64	3.48	222.06	3.17	22.50	343.27	3.91	222.07	3.14
$3\frac{7}{32}$x5 x$3\frac{7}{32}$x$\frac{1}{2}$	24.42	287.66	3.43	234.48	3.10	24.92	370.54	3.86	234.50	3.07
$3\frac{9}{32}$x$5\frac{1}{16}$x$3\frac{9}{32}$x$\frac{9}{16}$	27.58	321.15	3.41	273.70	3.15	28.14	414.03	3.83	273.72	3.12
$3\frac{11}{32}$x$5\frac{1}{8}$ x$3\frac{11}{32}$x$\frac{5}{8}$	30.78	354.33	3.39	315.67	3.20	31.40	457.20	3.81	315.69	3.17
$3\frac{1}{4}$ x5 x$3\frac{1}{4}$ x$\frac{11}{16}$	32.65	364.87	3.34	320.05	3.13	33.34	472.86	3.77	320.08	3.10
$3\frac{5}{16}$x$5\frac{1}{16}$x$3\frac{5}{16}$x$\frac{3}{4}$	35.81	395.55	3.32	363.02	3.18	36.56	513.07	3.74	363.05	3.15
	6″ Web Plate. 6¼″ Face to Face.					*7′ Web Plate. 7¼″ Face to Face.*				
$2\frac{7}{8}$ x4 x$2\frac{7}{8}$ x$\frac{1}{4}$	10.78	101.90	3.07	65.71	2.47	11.03	134.71	3.49	65.79	2.44
$2\frac{15}{16}$x$4\frac{1}{16}$x$2\frac{15}{16}$x$\frac{5}{16}$	13.52	126.14	3.05	85.80	2.52	13.83	166.94	3.47	85.80	2.49
3 x$4\frac{1}{8}$ x3 x $\frac{3}{8}$	16.33	150.56	3.04	107.87	2.57	16.71	199.42	3.45	107.87	2.54
$2\frac{31}{32}$x4 x$2\frac{31}{32}$x$\frac{7}{16}$	18.47	166.03	3.00	115.62	2.50	18.90	220.65	3.42	115.63	2.47
$3\frac{1}{32}$x$4\frac{1}{16}$x$3\frac{1}{32}$x $\frac{1}{2}$	21.24	188.60	2.98	138.66	2.55	21.74	250.89	3.40	138.67	2.52
$3\frac{3}{32}$x$4\frac{1}{8}$ x$3\frac{3}{32}$x$\frac{9}{16}$	24.02	210.64	2.96	163.07	2.60	24.58	280.45	3.38	163.08	2.58
$3\frac{1}{16}$x4 x$3\frac{3}{16}$x $\frac{5}{8}$	25.95	221.78	2.92	167.28	2.54	26.58	296.36	3.34	167.30	2.51
$3\frac{1}{8}$ x$4\frac{1}{16}$x$3\frac{1}{8}$ x$\frac{11}{16}$	28.69	242.16	2.91	192.77	2.59	29.37	323.88	3.32	192.80	2.56
$3\frac{3}{16}$x$4\frac{1}{8}$ x$3\frac{3}{16}$x $\frac{3}{4}$	31.50	262.65	2.89	220.51	2.64	32.25	351.59	3.30	220.55	2.61
	6″ Web Plate. 6¼″ Face to Face.					*7″ Web Plate. 7¼″ Face Face.*				
$2\frac{5}{8}$ x3 x$2\frac{5}{8}$ x $\frac{1}{4}$	9.26	84.78	3.03	31.74	1.85	9.51	112.65	3.44	31.74	1.83
$2\frac{11}{16}$x$3\frac{1}{16}$x$2\frac{11}{16}$x$\frac{5}{16}$	11.64	105.17	3.01	41.89	1.90	11.95	139.88	3.42	41.89	1.87
$2\frac{3}{4}$ x$3\frac{1}{8}$ x$2\frac{3}{4}$ x $\frac{3}{8}$	14.01	125.10	2.99	53.41	1.95	14.39	166.56	3.40	53.42	1.93
$2\frac{21}{32}$x3 x$2\frac{21}{32}$x$\frac{7}{16}$	15.63	134.64	2.93	55.24	1.88	16.06	180.30	3.35	55.25	1.85
$2\frac{23}{32}$x$3\frac{1}{16}$x$2\frac{23}{32}$x $\frac{1}{2}$	18.00	153.14	2.92	67.17	1.93	18.50	205.32	3.33	67.18	1.90

ELEMENTS OF PENCOYD Z BARS.



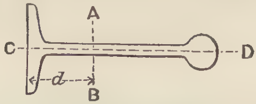
Sec. No.	Size in Inches.	Area in Sq. Ins.	Wt. per Foot in Lbs.	Moments of Inertia. Axis A. B.	Moments of Inertia. Axis C. D.	Moments of Inertia. Axis E. F.	Resistance. Axis A. B	Resistance. Axis C. D.
30Z	2 5/8 x 3 x 2 5/8 x 1/4	1.94	6.60	2.81	2.61	0.59	1.9	1.0
31Z	2 11/16 x 3 1/16 x 2 11/16 x 5/16	2.44	8.29	3.52	3.38	0.74	2.3	1.3
32Z	2 3/4 x 3 1/8 x 2 3/4 x 3/8	2.94	10.00	4.34	4.22	0.92	2.8	1.7
33Z	2 21/32 x 3 x 2 21/32 x 7/16	3.25	11.15	4.20	4.24	0.95	2.8	1.7
34Z	2 11/16 x 3 1/32 x 2 11/16 x 15/32	3.51	11.93	4.54	4.64	1.01	3.0	1.9
35Z	2 23/32 x 3 1/16 x 2 23/32 x 1/2	3.75	12.75	4.88	5.04	1.11	3.2	2.0
40Z	2 7/8 x 4 x 2 7/8 x 1/4	2.32	7.88	5.95	3.47	0.95	3.0	1.3
41Z	2 15/16 x 4 1/16 x 2 15/16 x 5/16	2.91	9.89	7.52	4.49	1.23	3.7	1.6
42Z	3 x 4 1/8 x 3 x 3/8	3.52	11.90	9.14	5.58	1.53	4.4	2.0
43Z	2 31/32 x 4 x 2 31/32 x 7/16	3.96	13.46	9.40	6.09	1.63	4.7	2.2
44Z	3 1/32 x 4 1/16 x 3 1/32 x 1/2	4.56	15.50	10.92	7.21	1.94	5.4	2.6
45Z	3 3/32 x 4 1/8 x 3 3/32 x 9/16	5.16	17.54	12.40	8.40	2.27	6.0	3.0
46Z	3 1/16 x 4 x 3 1/16 x 5/8	5.55	18.80	12.11	8.73	2.32	6.1	3.2
47Z	3 1/8 x 4 1/16 x 3 1/8 x 11/16	6.14	20.87	13.52	9.95	2.67	6.7	3.6
48Z	3 3/16 x 4 1/8 x 3 3/16 x 3/4	6.75	22.95	14.97	11.24	3.03	7.3	4.0
50Z	3 3/16 x 5 x 3 3/16 x 5/16	3.36	11.42	13.14	5.81	1.86	5.3	1.9
51Z	3 1/4 x 5 1/16 x 3 1/4 x 3/8	4.05	13.77	15.93	7.20	2.28	6.3	2.4
52Z	3 5/16 x 5 1/8 x 3 5/16 x 7/16	4.75	16.15	18.76	8.67	2.75	7.3	2.8
53Z	3 7/32 x 5 x 3 7/32 x 1/2	5.23	17.78	19.03	8.77	2.76	7.6	3.0
54Z	3 9/32 x 5 1/16 x 3 9/32 x 9/16	5.91	20.09	21.65	10.19	3.20	8.6	3.4
55Z	3 11/32 x 5 1/8 x 3 11/32 x 5/8	6.60	22.44	24.33	11.70	3.73	9.5	3.9
56Z	3 1/4 x 5 x 3 1/4 x 11/16	6.96	23.66	23.68	11.37	3.59	9.5	3.9
57Z	3 5/16 x 5 1/16 x 3 5/16 x 3/4	7.64	25.97	26.16	12.83	4.12	10.3	4.4
60Z	3 1/2 x 6 x 3 1/2 x 3/8	4.59	15.61	25.32	9.11	3.11	8.4	2.8
61Z	3 9/16 x 6 1/16 x 3 9/16 x 7/16	5.39	18.32	29.80	10.95	3.74	9.8	3.3
62Z	3 5/8 x 6 1/8 x 3 5/8 x 1/2	6.19	21.05	34.36	12.87	4.37	11.2	3.8
63Z	3 1/2 x 6 x 3 1/2 x 9/16	6.68	22.71	34.64	12.59	4.37	11.6	3.9
64Z	3 9/16 x 6 1/16 x 3 9/16 x 5/8	7.46	25.36	38.86	14.42	4.92	12.8	4.4
65Z	3 5/8 x 6 1/8 x 3 5/8 x 11/16	8.25	28.05	43.18	16.34	5.66	14.1	5.0
66Z	3 1/2 x 6 x 3 1/2 x 3/4	8.64	29.37	42.12	15.44	5.61	14.0	4.9
67Z	3 9/16 x 6 1/16 x 3 9/16 x 13/16	9.38	31.89	46.13	17.27	6.16	15.2	5.5
68Z	3 5/8 x 6 1/8 x 3 5/8 x 7/8	10.16	34.54	50.22	19.18	6.85	16.4	6.0

ELEMENTS OF PENCOYD Z BARS.



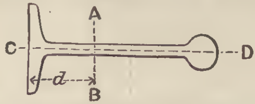
Radii of Gyration.			*Coef. in Net Tons for Greatest Safe Load Dis.*		*Coef. for Deflection About Axis A. B.*		*Max. Load in Net Tons.*	*Sec. No.*
Axis A. B.	*Axis C. D.*	*Least. Axis E. F.*	*Fibre Stress 16,000 lbs.*	*Fibre Stress 12,000 lbs.*	*Distributed.*	*Centre.*		
1.20	1.16	0.55	10.0	7.5	.0005694	.0009167	5.5	30Z
1.20	1.18	0.55	12.3	9.2	.0004545	.0007317	7.2	31Z
1.21	1.20	0.56	14.8	11.1	.0003687	.0005937	9.0	32Z
1.13	1.14	0.54	14.9	11.2	.0003809	.0006132	10.2	33Z
1.14	1.15	0.54	16.0	12.0	.0003524	.0005674	11.1	34Z
1.14	1.16	0.55	17.0	12.8	.0003279	.0005279	12.0	35Z
1.60	1.22	0.64	15.9	11.9	.0002689	.0004329	6.8	40Z
1.61	1.24	0.65	19.7	14.8	.0002128	.0003426	9.1	41Z
1.62	1.26	0.66	23.6	17.7	.0001750	.0002817	11.5	42Z
1.54	1.24	0.64	25.1	18.8	.0001702	.0002740	13.3	43Z
1.55	1.27	0.65	28.7	21.5	.0001465	.0002359	15 6	44Z
1.55	1.28	0.66	32.1	24.1	.0001290	.0002077	17.9	45Z
1.48	1.26	0.65	32.3	24.2	.0001321	.0002127	19.5	46Z
1.48	1.27	0.66	35.5	26.6	.0001183	.0001905	21.8	47Z
1.49	1.29	0.67	38.7	29.0	.0001069	.0001721	24.3	48Z
1.98	1.32	0.74	28.0	21.0	.0001218	.0001961	10.7	50Z
1.98	1.33	0.75	33.6	25.2	.0001005	.0001618	13.5	51Z
1.99	1.35	0.76	39.1	29.3	.0000853	.0001373	16.4	52Z
1.91	1.30	0.73	40.6	30.5	.0000841	.0001354	18.8	53Z
1.91	1.31	0.74	45.6	34.2	.0000739	.0001190	21.6	54Z
1.92	1.33	0.75	50.6	38.0	.0000658	.0001059	24.5	55Z
1.84	1.28	0.72	50.5	37.9	.0000676	.0001088	26.6	56Z
1.85	1.30	0.73	55.1	41.3	.0000612	.0000984	29.5	57Z
2.35	1.41	0.82	45.0	33.8	.0000632	.0001017	15.4	60Z
2.35	1.43	0.83	52.4	39.3	.0000537	.0000864	18.8	61Z
2.36	1.44	0.84	59.8	44.9	.0000466	.0000750	22.3	62Z
2.28	1.37	0.81	61.6	46.2	.0000462	.0000744	25.1	63Z
2.28	1.39	0.81	68.4	51.3	.0000412	.0000663	28.5	64Z
2.29	1.41	0.83	75.2	56.4	.0000370	.0000596	32.0	65Z
2.21	1.34	0.81	74.9	56.2	.0000380	.0000612	34.5	66Z
2.22	1.36	0.81	81.2	60.9	.0000347	.0000559	38.0	67Z
2.22	1.37	0.82	87.5	65.6	.0000319	.0000513	41.5	68Z

ELEMENTS OF PENCOYD DECK BEAMS.



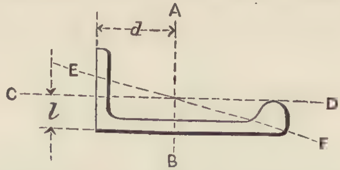
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Size in Ins.	*Section No.*	*Area in Sq. Inches.*	*Weight per Foot in Lbs.*	*Moments of Inertia.*		*Square of Radius of Gyration.*		*Radius of Gyration.*	
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*
11½	110D	9.51	32.2	179.33	6.36	18.86	0.67	4.34	0.82
11½	116D	13.41	45.6	224.19	8.14	16.72	0.61	4.09	0.78
10	100D	8.20	28.0	118.55	6.08	14.46	0.74	3.80	0.86
10	105D	11.32	38.6	145.77	7.54	12.88	0.67	3.59	0.82
9	90D	7.35	25.0	84.99	4.85	11.56	0.66	3.40	0.81
9	94D	9.60	32.6	100.68	5.78	10.49	0.60	3.24	0.77
8	80D	6.17	21.0	57.75	3.58	9.36	0.58	3.06	0.76
8	85D	8.43	28.6	70.19	4.44	8.33	0.53	2.89	0.73
7	70D	5.32	18.0	36.99	2.56	6.95	0.48	2.64	0.69
7	75D	7.29	24.5	45.32	3.26	6.22	0.45	2.49	0.67
6	60D	4.27	14.5	21.83	1.62	5.11	0.38	2.26	0.62
6	64D	5.77	19.6	26.50	2.07	4.59	0.36	2.14	0.60
5	50D	3.39	11.5	11.96	1.01	3.53	0.30	1.88	0.55
5	55D	4.64	15.8	14.64	1.29	3.16	0.28	1.78	0.53

ELEMENTS OF PENCOYD DECK BEAMS.



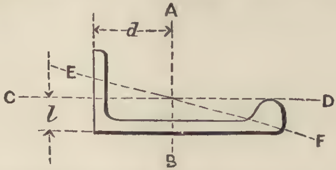
XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII	II.	I.
Resistance. Axis A. B.	*Add to Resist. for each Add'l Pound per Ft.*	*Coef. Great. Safe Load in Net Tons.*	*Add to Prev's Coef for Add'l Pound per Ft.*	*Coefficient for Deflection.*		*Max. Load in Net Tons.*	*Dist. "d" from Base to Neut. Axis*	*Section No.*	*Size in Ins.*
				Distrib'd Load.	*Centre Load.*				
27.9	0.60	148.7	3.22	.0000089	.0000143	24.3	5.07	110D	11½
36.0	0.60	191.9	3.22	.0000071	.0000114	59.7	5.27	110D	11½
20.7	0.54	110.5	2.86	.0000135	·0000217	20.4	4.28	100D	10
26.4	0.54	140.8	2.86	.0000107	.0000172	48.2	4.48	100D	10
16.7	0.48	88.9	2.55	.0000188	.0000303	19.5	3.90	90D	9
20.3	0.48	108.3	2.55	.0000159	.0000256	39.5	4.04	90D	9
12.8	0.43	68.1	2.28	.0000277	.0000446	16.2	3.48	80D	8
16.0	0.43	85.5	2.28	.0000228	.0000367	36.1	3.62	80D	8
9.3	0.38	49.8	2.02	.0000432	.0000695	15.1	3.04	70D	7
11.8	0.38	62.9	2.02	.0000352	.0000568	32.3	3.16	70D	7
6.4	0.32	34.3	1.69	.0000733	.0001180	12.0	2.61	60D	6
8.1	0.32	43.0	1.69	.0000604	.0000972	25.1	2.71	60D	6
4.3	0.26	22.9	1.39	.0001337	.0002147	10.7	2.22	50D	5
5.4	0.26	28.9	1.39	.0001093	.0001755	21.4	2.30	50D	5

ELEMENTS OF PENCOYD BULB ANGLES.



I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII
Size in Ins.	*Sec. No.*	*Area in Sq. Ins.*	*Wt. per Foot in Lbs.*	*Moments of Inertia.*			*Square of Radius of Gyration.*			*Radius of Gyration.*		
				Axis A. B.	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*Axis E. F.*
10	100 A	7.56	25.59	90.90	5.03	5.17	12.02	0.67	0.68	3.47	0.82	0.82
10	100 A	9.28	31.55	111.10	6.81	7.29	11.97	0.73	0.79	3.46	0.86	0.89
9	90 A	6.65	22.61	65.51	4.40	4.38	9.85	0.66	0.66	3.14	0.81	0.81
9	90 A	7.63	25.94	75.00	5.32	5.37	9.83	0.70	0.70	3.14	0.84	0.84
8	80 A	5.71	19.41	44.92	3.59	3.16	7.87	0.63	0.55	2.81	0.79	0.74
8	80 A	7.07	24.04	54.64	4.86	4.67	7.73	0.69	0.66	2.78	0.83	0.81
7	70 A	4.67	15.89	28.68	2.72	2.74	6.14	0.58	0.59	2.48	0.76	0.77
7	70 A	5.64	19.18	34.42	3.53	3.27	6.10	0.63	0.58	2.47	0.79	0.76
6	60 A	3.74	12.73	17.26	1.96	1.92	4.61	0.52	0.51	2.15	0.72	0.72
6	60 A	5.61	19.07	25.66	4.03	3.11	4.57	0.72	0.55	2.14	0.85	0.74
5	50 A	2.85	9.69	9.20	1.29	1.20	3.23	0.45	0.42	1.80	0.67	0.65
5	50 A	3.79	12.89	12.44	1.95	1.74	3.28	0.51	0.46	1.81	0.72	0.68

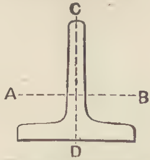
ELEMENTS OF PENCOYD BULB ANGLES.



XIV. Resistance. Axis A. B.	XV. Add to Resist. for Add'l Pound per Ft.	XVI. Coef. Great. Safe Load in Net Tons.	XVII. Add to XVI. for Add'l Pound per Ft.	XVIII. Coefficient for Deflection. Distrib'd Load.	XIX. Coefficient for Deflection. Centre Load.	XX. Max. Load in Net Tons.	XXI. Dist. "d" from Base to Neu. Axis.	XXII Dist. "l" from Base to Neu. Axis.	II. Sec. No.	I. Size in Ins.
16.2	0.58	86.4	3.10	.0000176	.0000282	31.6	4.39	0.70	100A	10
19.7	0.58	104.9	3.10	.0000144	.0000231	42.7	4.35	0.77	100A	10
12.9	0.56	68.8	2.99	.0000244	.0000391	28.3	3.92	0.69	90A	9
14.8	0.56	78.7	2.99	.0000213	.0000342	34.6	3.92	0.74	90A	9
9.9	0.43	52.7	2.28	.0000356	.0000571	24.0	3.45	0.69	80A	8
11.9	0.43	63.2	2.28	.0000293	.0000448	31.7	3.39	0.74	80A	8
7.2	0.43	38.5	2.27	.0000558	.0000894	19.0	3.03	0.66	70A	7
8.6	0.43	46.0	2.27	.0000465	.0000745	24.8	3.01	0.72	70A	7
5.1	0.38	27.2	2.05	.0000927	.0001486	14.5	2.61	0.64	60A	6
7.5	0.38	40.1	2.05	.0000624	.0000999	25.1	2.59	0.77	60A	6
3.2	0.35	17.2	1.89	.0001739	.0002787	10.7	2.15	0.60	50A	5
4.4	0.35	23.3	1.89	.0001286	.0002061	16.1	2.15	0.69	50A	5

ELEMENTS OF PENCOYD TEES.

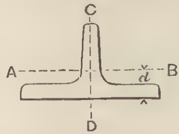
EVEN LEGS.



I.	II.	III.	IV.	V.	VI.	VII.	VIII	IX.	X.	XI.	I.
Sec. No.	*Size in Inches.*	*Area in Sq. Ins.*	*Wt. per Foot in Lbs.*	*Moments of Inertia.*		*Resistance.*		*Radius of Gyration.*		*Dist. "d" from Base to N. Axis.*	*Sec. No.*
				Axis A. B.	*Axis C. D.*	*Axis A.B.*	*Axis C. D.*	*Axis A.B.*	*Axis C. D.*		
440T	4 x 4	3.10	10.9	4.70	2.20	1.64	1.10	1.23	0.85	1.15	440T
441T	4 x 4	3.98	13.7	5.70	2.79	2.02	1.40	1.20	0.84	1.18	441T
335T	3½ x 3½	2.08	7.0	2.27	1.03	0.89	0.59	1.04	0.71	0.94	335T
336T	3½ x 3½	2.65	9.0	2.83	1.32	1.16	0.75	1.03	0.71	1.06	336T
337T	3½ x 3 ½	3.24	11.0	3.61	1.75	1.49	1.00	1.05	0.73	1.07	337T
330T	3 x 3	1.91	6.5	1.57	0.75	0.74	0.50	0.91	0.62	0.87	330T
331T	3 x 3	2.27	7.7	1.82	0.89	0.86	0.60	0.89	0.62	0.88	331T
225T	2½ x 2½	1.47	5.0	0.79	0.38	0.44	0.30	0.73	0.51	0.69	225T
226T	2½ x 2½	1.71	5.8	0.95	0.48	0.55	0.38	0.75	0.53	0.76	226T
227T	2½ x 2½	1.94	6.6	1.08	0.56	0.63	0.45	0.75	0.54	0.79	227T
222T	2¼ x 2¼	1.18	4.0	0.51	0.27	0.31	0.24	0.66	0.48	0.62	222T
223T	2¼ x 2¼	1.18	4.0	0.52	0.26	0.33	0.23	0.66	0 47	0.65	223T
220T	2 x 2	1.03	3.5	0.37	0.18	0.26	0.18	0.60	0.41	0.60	220T
117T	1¾ x 1¾	0.71	2.4	0.19	0.09	0.15	0.10	0.52	0.36	0.51	117T
115T	1½ x 1½	0.59	2.0	0.12	0.06	0.12	0.08	0.45	0.32	0.47	115T
112T	1¼ x 1¼	0.44	1.5	0.07	0.04	0.09	0.06	0.40	0.30	0.43	112T
110T	1 x 1	0.29	1.0	0.03	0.02	0.05	0.04	0.32	0.26	0.38	110T

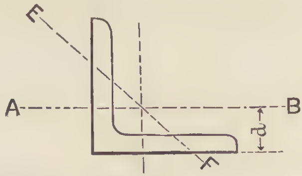
ELEMENTS OF PENCOYD TEES.

UNEVEN LEGS.



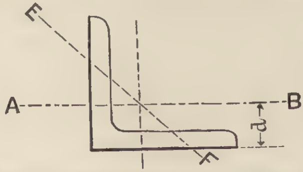
I.	II.	III.	IV.	V.	VI.	VII.	VIII	IX.	X.	XI.	I.
Sec. No.	*Size in Inches.*	*Area in Sq. Ins.*	*Wt. per Foot in Lbs.*	*Moments of Inertia.*		*Resistance.*		*Radius of Gyration.*		*Dist. "d" from Base to N. Axis.*	*Sec. No.*
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*		
64T	6 x 4	5.12	17.4	6.56	9.33	2.19	3.11	1.13	1.35	1.00	64T
65T	6 x $5\frac{1}{4}$	11.58	39.0	28.68	18.75	8.19	6.25	1.57	1.27	1.75	65T
53T	5 x $3\frac{1}{2}$	4.95	17.0	5.29	5.47	2.17	2.19	1.03	1.05	1.06	53T
54T	5 x 4	4.54	15.3	6.16	5.41	2.11	2.16	1.17	1.09	1.08	54T
42T	4 x 2	1.93	6.5	0.53	1.75	0.34	0.87	0.52	0.95	0.46	42T
43T	4 x 3	2.67	9.0	1.99	2.10	0.90	1.05	0.87	0.89	0.78	43T
44T	4 x 3	3.05	10.2	2.24	2.44	1.02	1.22	0.85	0.89	0.81	44T
45T	4 x $4\frac{1}{2}$	3.97	13.5	7.36	2.53	2.33	1.27	1.36	0.80	1.34	45T
38T	$3\frac{1}{2}$ x 3	2.11	7.0	1.65	1.18	0.75	0.67	0.88	0.75	0.80	38T
39T	$3\frac{1}{2}$ x 3	2.46	8.5	1.91	1.41	0.88	0.81	0.88	0.75	0.83	39T
30T	3 x $1\frac{1}{2}$	1.20	4.0	0.18	0.60	0.16	0.40	0.39	0.71	0.36	30T
31T	3 x $2\frac{1}{2}$	1.46	5.0	0.78	0.60	0.42	0.40	0.73	0.64	0.66	31T
32T	3 x $2\frac{1}{2}$	1.76	6.0	0.93	0.74	0.51	0.49	0.73	0.65	0.68	32T
33T	3 x $2\frac{1}{2}$	2.06	7.0	1.08	0.89	0.60	0.59	0.72	0.66	0.71	33T
34T	3 x $2\frac{1}{2}$	2.38	8.0	1.32	0.91	0.78	0.61	0.74	0.62	0.80	34T
35T	3 x $3\frac{1}{2}$	2.46	8.3	2.82	0.89	1.17	0.59	1.07	0.60	1.08	35T
36T	3 x $3\frac{1}{2}$	2.81	9.5	3.19	1.04	1.33	0.69	1.07	0.61	1.10	36T
28T	$2\frac{3}{4}$ x $1\frac{3}{4}$	1.96	6.6	0.56	0.60	0.50	0.44	0.54	0.56	0.64	28T
29T	$2\frac{3}{4}$ x 2	2.14	7.2	0.82	0.61	0.66	0.44	0.62	0.54	0.75	29T
25T	$2\frac{1}{2}$ x $1\frac{1}{4}$	0.97	3.3	0.10	0.33	0.11	0.26	0.32	0.58	0.31	25T
26T	$2\frac{1}{2}$ x $2\frac{3}{4}$	1.68	5.7	1.16	0.43	0.60	0.34	0.83	0.51	0.83	26T
27T	$2\frac{1}{2}$ x 3	1.76	6.0	1.48	0.44	0.71	0.35	0.92	0.50	0.93	27T
24T	$2\frac{1}{4}$ x $\frac{9}{16}$	0.66	2.2	0.01	0.24	0.03	0.21	0.14	0.60	0.17	24T
20T	2 x $\frac{9}{16}$	0.60	2.0	0.01	0.17	0.03	0.17	0.14	0.53	0.17	20T
22T	2 x $1\frac{1}{16}$	0.62	2.0	0.04	0.16	0.05	0.16	0.24	0.51	0.23	22T
21T	2 x 1	0.72	2.5	0.05	0.17	0.07	0.17	0.26	0.49	0.27	21T
23T	2 x $1\frac{1}{2}$	0.91	3.0	0.16	0.17	0.15	0.17	0.42	0.44	0.45	23T
17T	$1\frac{3}{4}$ x $1\frac{1}{16}$	0.56	1.9	0.05	0.11	0.06	0.13	0.30	0.45	0.24	17T
18T	$1\frac{3}{4}$ x $1\frac{1}{4}$	1.04	3.5	0.12	0.21	0.14	0.24	0.35	0.45	0.40	18T
15T	$1\frac{1}{2}$ x $\frac{15}{16}$	0.41	1.4	0.02	0.07	0.03	0.09	0.22	0.41	0.21	15T
12T	$1\frac{1}{4}$ x $\frac{15}{16}$	0.35	1.2	0.02	0.03	0.03	0.05	0.24	0.30	0.22	12T

ELEMENTS OF PENCOYD ANGLES.



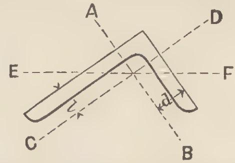
I.	II.	III.	IV.	V.	VI.	VII.
Section Number.	*Size in Inches.*	*Thickness.*	*Area in Sq. Inches.*	*Weight per Foot in Lbs.*	*Moments of Inertia.*	
					Axis A. B.	*Axis E. F.*
880A	8 x 8	½	7.75	26.4	48.47	19.60
888A	8¼ x 8¼	1	15.29	52.8	94.14	39.01
660A	6 x 6	⅜	4.36	14.8	15.37	6.20
669A	6¼ x 6¼	15/16	10.65	35.9	36.69	15.48
550A	5 x 5	⅜	3.61	12.3	8.73	3.54
559A	5¼ x 5¼	15/16	8.77	29.4	20.72	9.09
440A	4 x 4	5/16	2.40	8.2	3.69	1.50
447A	4¼ x 4¼	¾	5.69	18.6	8.71	3.82
350A	3½ x 3½	5/16	2.09	7.1	2.45	0.99
355A	3⅝ x 3⅝	⅝	4.06	13.7	4.60	1.97
330A	3 x 3	¼	1.44	4.9	1.25	0.50
336A	3 3/16 x 3 3/16	⅝	3.51	11.5	3.01	1.32
275A	2¾ x 2¾	¼	1.31	4.5	0.95	0.39
279A	3 x 3	½	2.70	8.6	2.11	0.90
250A	2½ x 2½	3/16	0.90	3.1	0.54	0.22
255A	2⅝ x 2⅝	½	2.33	7.8	1.33	0.59
225A	2¼ x 2¼	3/16	0.81	2.7	0.39	0.16
228A	2 7/16 x 2 7/16	⅜	1.66	5.4	0.85	0.37
220A	2 x 2	3/16	0.71	2.5	0.27	0.11
223A	2 3/16 x 2 3/16	⅜	1.47	4.8	0.61	0.26
175A	1¾ x 1¾	3/16	0.62	2.1	0.18	0.08
178A	1 15/16 x 1 15/16	⅜	1.28	4.1	0.39	0.18
150A	1½ x 1½	⅛	0.36	1.2	0.08	0.03
154A	1¾ x 1¾	⅜	1.14	3.5	0.29	0.13
125A	1¼ x 1¼	⅛	0.30	1.0	0.05	0.02
127A	1⅜ x 1⅜	¼	0.62	2.0	0.10	0.04
110A	1 x 1	⅛	0.23	0.8	0.02	0.01
112A	1⅛ x 1⅛	¼	0.49	1.5	0.05	0.02

ELEMENTS OF PENCOYD ANGLES.



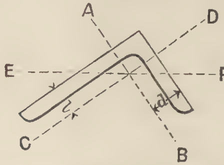
VIII.	IX.	X.	XI.	I.
Radii of Gyration.		*Resistance.*	*Distance from Base to Neutral Axis.*	*Section Number.*
Axis A. B.	*Axis E. F.*	*Axis A. B.*	*"d."*	
2.50	1.59	8.34	2.19	880A
2.48	1.60	16.18	2.43	888A
1.88	1.19	3.53	1.64	660A
1.86	1.21	8.43	1.90	669A
1.56	0.99	2.42	1.39	550A
1.54	1.02	5.76	1.65	559A
1.24	0.79	1.28	1.12	440A
1.24	0.82	3.10	1.34	447A
1.08	0.69	0.98	0.99	350A
1.06	0.70	1.84	1.13	355A
0.93	0.59	0.58	0.84	330A
0.93	0.61	1.39	1.02	336A
0.85	0.55	0.48	0.78	275A
0.88	0.58	1.02	0.93	279A
0.77	0.49	0.30	0.70	250A
0.76	0.50	0.75	0.84	255A
0.69	0.44	0.24	0.63	225A
0.72	0.47	0.50	0.75	228A
0.62	0.39	0.19	0.58	220A
0.64	0.42	0.40	0.68	223A
0.54	0.36	0.15	0.51	175A
0.55	0.38	0.30	0.63	178A
0.47	0.28	0.07	0.42	150A
0.50	0.34	0.25	0.57	154A
0.41	0.26	0.06	0.35	125A
0.40	0.25	0.11	0.43	127A
0.29	0.21	0.03	0.30	110A
0.32	0.20	0.07	0.37	112A

ELEMENTS OF PENCOYD ANGLES.



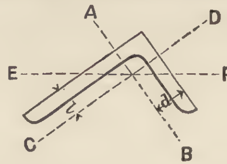
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Section Number.	Size in Inches.	Thickness.	Area in Sq. Ins.	Weight per Foot in Lbs.	Moments of Inertia.		
					Axis A. B.	Axis C. B.	Axis E. F.
860A	8 x 6	1/2	6.75	23.0	44.38	21.73	12.04
868A	8 1/4 x 6 1/4	1	13.29	45.6	85.34	41.67	24.76
730A	7 x 3 1/2	1/2	5.00	17.0	25.29	4.37	3.64
738A	7 1/4 x 3 3/4	1	9.79	32.5	48.59	8.47	7.47
650A	6 1/2 x 4	3/8	3.80	12.9	16.83	5.03	3.29
659A	6 7/8 x 4 3/8	15/16	9.48	31.9	42.40	12.91	9.28
640A	6 x 4	3/8	3.61	12.2	13.48	4.91	3.04
649A	6 3/8 x 4 3/8	15/16	9.01	29.4	33.95	12.47	8.57
630A	6 x 3 1/2	3/8	3.42	11.6	12.82	3.32	2.39
639A	6 3/8 x 3 7/8	15/16	8.54	28.6	32.56	7.74	6.50
500A	5 1/2 x 3 1/2	3/8	3.23	11.0	10.15	3.28	2.14
504A	5 3/4 x 3 3/4	5/8	5.47	17.9	17.62	5.85	3.82
540A	5 x 4	3/8	3.23	11.0	8.13	4.65	2.50
546A	5 3/16 x 4 3/16	3/4	6.35	21.3	15.65	8.74	4.95
510A	5 x 3 1/2	5/16	2.56	8.7	6.58	2.71	1.65
517A	5 1/4 x 3 3/4	3/4	6.07	20.0	15.51	6.41	4.17
530A	5 x 3	5/16	2.40	8.2	6.27	1.75	1.20
537A	5 1/4 x 3 1/4	3/4	5.69	18.7	14.75	4.18	3.05
450A	4 1/2 x 3	5/16	2.25	7.7	4.72	1.72	1.10
457A	4 3/4 x 3 1/4	3/4	5.32	17.4	11.04	4.07	2.96
410A	4 x 3 1/2	5/16	2.25	7.7	3.57	2.56	1.18
417A	4 1/4 x 3 3/4	3/4	5.32	17.4	8.42	6.06	3.08

ELEMENTS OF PENCOYD ANGLES.



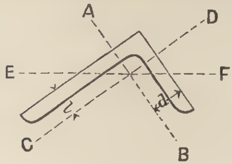
IX.	X.	XI.	XII.	XIII.	XIV.	XV.	I.
Radius of Gyration.			*Resistance.*		*Distance from Base to Neutral Axis.*		*Section Number.*
Axis A. B.	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*d.*	*l.*	
2.56	1.79	1.34	8.03	4.80	2.47	1.47	860A
2.53	1.77	1.37	15.43	9.20	2.72	1.72	868A
2.25	0.93	0.85	5.66	1.61	2.53	0.78	730A
2.23	0.93	0.87	10.85	3.10	2.77	1.02	738A
2.10	1.15	0.93	3.87	1.62	2.15	0.90	650A
2.12	1.17	0.99	9.58	4.07	2.45	1.20	659A
1.93	1.17	0.92	3.32	1.60	1.94	0.94	640A
1.94	1.18	0.98	8.21	3.98	2.24	1.24	649A
1.94	0.99	0.84	3.24	1.23	2.04	0.79	630A
1.95	0.95	0.87	8.05	2.77	2.33	1.08	639A
1.77	1.01	0.81	2.76	1.22	1.82	0.82	500A
1.79	1.03	0.84	4.66	2.10	1.97	0.97	504A
1.59	1.20	0 88	2.34	1.57	1.53	1.03	540A
1.57	1.17	0.88	4.50	2.93	1.71	1.21	546A
1.60	1.03	0.80	1.93	1.02	1.59	0.84	510A
1.60	1.03	0.83	4.51	2.38	1.81	1.06	517A
1.62	0.85	0.71	1.89	0.75	1.68	0.68	530A
1.61	0.86	0.73	4.40	1.78	1.90	0.90	537A
1.45	0.87	0.70	1.55	0.75	1.46	0.71	450A
1.44	0.87	0.75	3.61	1.76	1.69	0.94	457A
1.26	1.07	0.72	1.27	1.00	1.18	0.93	410A
1.26	1.07	0.76	2.95	2.33	1.40	1.15	417A

ELEMENTS OF PENCOYD ANGLES.



I.	II.	III.	IV.	V.	VI.	VII.	VIII.
					Moments of Inertia.		
Section Number.	*Size in Inches.*	*Thick-ness.*	*Area in Sq. Ins.*	*Weight per Foot in Lbs.*	*Axis A. B.*	*Axis C. D.*	*Axis E. F.*
430A	4 x 3	5/16	2.09	7.1	3.38	1.64	0.93
435A	4 1/8 x 3 1/8	5/8	4.06	13.8	6.36	2.59	1.80
300A	3 1/2 x 3	5/16	1.93	6.6	2.33	1.59	0.80
305A	3 13/16 x 3 5/16	5/8	3.98	12.9	5.12	3.54	1.88
310A	3 1/2 x 2 1/2	1/4	1.44	4.9	1.81	0.78	0.45
314A	3 3/4 x 2 3/4	1/2	2.95	9.4	3.93	1.76	1.01
316A	3 1/2 x 2	1/4	1.31	4.5	1.66	0.41	0.30
318A	3 5/8 x 2 1/8	3/8	1.99	6.6	2.55	0.65	0.45
325A	3 x 2 1/2	1/4	1.31	4.5	1.15	0.73	0.41
329A	3 1/4 x 2 3/4	1/2	2.70	8.7	2.64	1.71	0.76
320A	3 x 2	1/4	1.19	4.1	1.09	0.40	0.24
324A	3 1/4 x 2 1/4	1/2	2.45	7.9	2.41	0.92	0.57
200A	2 1/2 x 2	3/16	0.81	2.7	0.51	0.29	0.13
205A	2 13/16 x 2 5/16	1/2	2.26	7.0	1.64	0.97	0.44
206A	2 1/4 x 1 1/2	3/16	0.67	2.3	0.35	0.12	0.08
209A	2 7/16 x 1 11/16	3/8	1.38	4.4	0.73	0.29	0.18
215A	2 x 1 1/2	3/16	0.62	2.1	0.25	0.12	0.07
218A	2 3/16 x 1 11/16	3/8	1.28	4.3	0.52	0.29	0.15
210A	2 x 1 1/4	3/16	0.57	1.9	0.23	0.07	0.05
213A	2 3/16 x 1 7/16	3/8	1.19	3.9	0.50	0.17	0.12

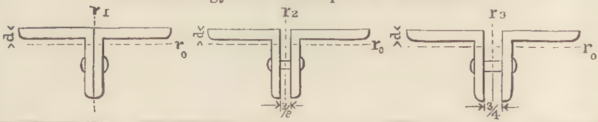
ELEMENTS OF PENCOYD ANGLES.



IX.	X.	XI.	XII.	XIII.	XIV.	XV.	I.
Radius of Gyration.			*Resistance.*		*Distance from Base to Neutral Axis.*		*Section Number.*
Axis A. B.	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*d.*	*l.*	
1.27	0.89	0.67	1.23	0.73	1.26	0.76	430A
1.25	0.80	0.67	2.33	1.16	1.40	0.90	435A
1.10	0.91	0.64	0.95	0.73	1.06	0.81	300A
1.13	0.95	0.69	2.00	1.53	1.25	1.00	305A
1.12	0.74	0.56	0.76	0.41	1.11	0.61	310A
1.15	0.77	0.59	1.58	0.88	1.26	0.76	314A
1.13	0.56	0.48	0.72	0.27	1.21	0.46	316A
1.13	0.57	0.48	1.09	0.41	1.28	0.53	318A
0.94	0.75	0.56	0.55	0.40	0.92	0.67	325A
0.99	0.80	0.53	1.20	0.88	1.05	0.80	329A
0.96	0.58	0.45	0.54	0.26	0.99	0.49	320A
0.99	0.61	0.48	1.14	0.57	1.14	0.64	324A
0.79	0.60	0.40	0.29	0.19	0.76	0.51	200A
0.85	0.66	0.44	0.88	0.60	0.94	0.69	205A
0.72	0.42	0.35	0.23	0.11	0.74	0.37	206A
0.73	0.46	0.36	0.46	0.24	0.86	0.48	209A
0.63	0.44	0.34	0.18	0.11	0.64	0.39	215A
0.64	0.48	0.34	0.36	0.24	0.76	0.50	218A
0.64	0.35	0.30	0.18	0.07	0.69	0.31	210A
0.65	0.38	0.32	0.36	0.17	0.80	0.42	213A

RADII OF GYRATION FOR 2 ANGLES WITH SIDES PARALLEL.

The radii of gyration correspond to axes shown.

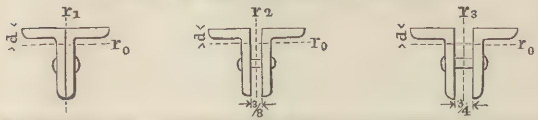


Size in Inches.	Thickness.	Weight per Foot in Pounds.	d	RADII GYRATION.			
				r_0	r_1	r_2	r_3
8 x 8	1/2	26.4	2.19	2.50	3.32	3.45	3.58
8 1/4 x 8 1/4	1	52.8	2.43	2.48	3.47	3.61	3.74
6 x 6	3/8	14.8	1.64	1.88	2.49	2.62	2.76
6 1/4 x 6 1/4	15/16	35.9	1.90	1.86	2.66	2.80	2.94
5 x 5	3/8	12.3	1.39	1.56	2.09	2.22	2.35
5 1/4 x 5 1/4	15/16	29.4	1.65	1.54	2.26	2.40	2.54
4 x 4	5/16	8.2	1.12	1.24	1.67	1.80	1.94
4 1/4 x 4 1/4	3/4	18.6	1.34	1.24	1.82	1.97	2.12
3 1/2 x 3 1/2	5/16	7.1	0.99	1.08	1.46	1.60	1.74
3 5/8 x 3 5/8	5/8	13.7	1.13	1.06	1.55	1.69	1.84
3 x 3	1/4	4.9	0.84	0.93	1.25	1.39	1.53
3 3/16 x 3 3/16	5/8	11.5	1.02	0.93	1.38	1.52	1.68
2 3/4 x 2 3/4	1/4	4.5	0.78	0.85	1.15	1.29	1.43
3 x 3	1/2	8.6	0.93	0.88	1.28	1.42	1.57
2 1/2 x 2 1/2	3/16	3.1	0.70	0.77	1.04	1.17	1.32
2 5/8 x 2 5/8	1/2	7.8	0.84	0.76	1.13	1.28	1.43
2 1/4 x 2 1/4	3/16	2.7	0.63	0.69	0.93	1.07	1.21
2 7/16 x 2 7/16	3/8	5.4	0.75	0.72	1.04	1.18	1.34
2 x 2	3/16	2.5	0.58	0.62	0.85	0.99	1.14
2 3/16 x 2 3/16	3/8	4.8	0.68	0.64	0.93	1.08	1.23
1 3/4 x 1 3/4	3/16	2.1	0.51	6.54	0.74	0.88	1.04
1 15/16 x 1 15/16	3/8	4.1	0.63	0.55	0.84	0.98	1.14
1 1/2 x 1 1/2	1/8	1.2	0.42	6.47	0.63	0.77	0.92
1 3/4 x 1 3/4	3/8	3.5	0.57	0.50	0.76	0.91	1.07
1 1/4 x 1 1/4	1/8	1.0	0.35	0.41	0.54	0.68	0.83
1 3/8 x 1 3/8	1/4	2.0	0.43	0.40	0.59	0.73	0.90
1 x 1	1/8	0.8	0.30	0.29	0.42	0.57	0.73
1 1/8 x 1 1/8	1/4	1.5	0.37	0.32	0.49	0.64	0.81

r_1, r_2 and r_3 will also be radii of gyration for star columns.

RADII OF GYRATION FOR 2 ANGLES WITH SIDES PARALLEL.

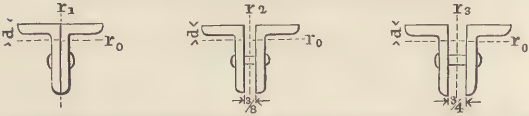
The radii of gyration correspond to axes shown.



Size in Inches.	Thick-ness.	Weight per Foot in Pounds.	d	RADII OF GYRATION. r_0	r_1	r_2	r_3
8 x 6	1/2	23.0	2.47	2.56	2.32	2.44	2.57
8 1/4 x 6 1/4	1	45.6	2.72	2.53	2.47	2.60	2.74
7 x 3 1/2	1/2	17.0	2.53	2.25	1.21	1.34	1.48
7 1/4 x 3 3/4	1	32.5	2.77	2.23	1.38	1.51	1.68
6 1/2 x 4	3/8	12.9	2.15	2.10	1.46	1.58	1.72
6 7/8 x 4 3/8	15/16	31.9	2.45	2.12	1.68	1.81	1.96
6 x 4	3/8	12.2	1.94	1.93	1.50	1.62	1.76
6 3/8 x 4 3/8	15/16	29.4	2.24	1.94	1.71	1.85	2.00
6 x 3 1/2	3/8	11.6	2.04	1.94	1.27	1.39	1.53
6 3/8 x 3 7/8	15/16	28.6	2.33	1.95	1.44	1.58	1.74
5 1/2 x 3 1/2	3/8	11.0	1.82	1.77	1.30	1.43	1.56
5 3/4 x 3 3/4	5/8	17.9	1.97	1.79	1.41	1.55	1.69
5 x 4	3/8	11.0	1.53	1.59	1.58	1.71	1.85
5 3/16 x 4 3/16	3/4	21.3	1.71	1.57	1.68	1.82	1.97
5 x 3 1/2	5/16	8.7	1.59	1.60	1.33	1.45	1.59
5 1/4 x 3 3/4	3/4	20.0	1.81	1.60	1.48	1.62	1.77
5 x 3	5/16	8.2	1.68	1.62	1.09	1.21	1.35
5 1/4 x 3 1/4	3/4	18.7	1.90	1.61	1.24	1.39	1.54
4 1/2 x 3	5/16	7.7	1.46	1.45	1.12	1.25	1.39
4 3/4 x 3 1/4	3/4	17.4	1.69	1.44	1.28	1.42	1.58

RADII OF GYRATION FOR 2 ANGLES WITH SIDES PARALLEL.

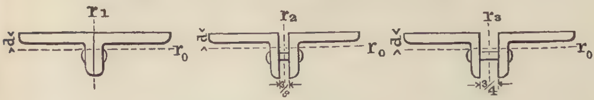
The radii of gyration correspond to axes shown.



Size in Inches.	*Thickness.*	*Weight per Foot in Pounds.*	*d*	*RADII OF GYRATION.* r_0	r_1	r_2	r_3
4 x 3 1/2	5/16	7.7	1.18	1.26	1.42	1.55	1.69
4 1/4 x 3 3/4	3/4	17.4	1.40	1.26	1.57	1.71	1.86
4 x 3	5/16	7.1	1.26	1.27	1.17	1.30	1.44
4 1/8 x 3 1/8	5/8	13.8	1.40	1.25	1.20	1.35	1.50
3 1/2 x 3	5/16	6.6	1.06	1.10	1.22	1.35	1.49
3 13/16 x 3 5/16	5/8	12.9	1.25	1.13	1.38	1.52	1.67
3 1/2 x 2 1/2	1/4	4.9	1.11	1.12	0.97	1.09	1.23
3 3/4 x 2 3/4	1/2	9.4	1.26	1.15	1.08	1.22	1.37
3 1/2 x 2	1/4	4.5	1.21	1.13	0.72	0.86	1.00
3 5/8 x 2 1/8	3/8	6.6	1.28	1.13	0.78	0.92	1.07
3 x 2 1/2	1/4	4.5	0.92	0.94	1.00	1.13	1.29
3 1/4 x 2 3/4	1/2	8.7	1.05	0.99	1.13	1.27	1.42
3 x 2	1/4	4.1	0.99	0.96	0.76	0.89	1.04
3 1/4 x 2 1/4	1/2	7.9	1.14	0.99	0.88	1.03	1.18
2 1/2 x 2	3/16	2.7	0.76	0.79	0.79	0.92	1.07
2 13/16 x 2 5/16	1/2	7.0	0.94	0.85	0.95	1.09	1.24
2 1/4 x 1 1/2	3/16	2.3	0.74	0.72	0.56	0.70	0.85
2 7/16 x 1 11/16	3/8	4.4	0.86	0.73	0.66	0.81	0.97
2 x 1 1/2	3/16	2.1	0.64	0.63	0.59	0.73	0.88
2 3/16 x 1 11/16	3/8	4.3	0.76	0.64	0.69	0.84	1.00
2 x 1 1/4	3/16	1.9	0.69	0.64	0.47	0.61	0.77
2 3/16 x 1 7/16	3/8	3.9	0.80	0.65	0.57	0.72	0.88

RADII OF GYRATION FOR 2 ANGLES WITH SIDES PARALLEL.

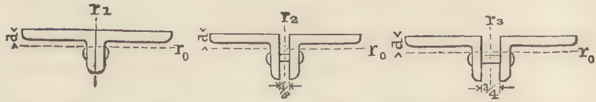
The radii of gyration correspond to axes shown.



Size in Inches.	Thickness.	Weight per Foot in Pounds.	d	RADII OF GYRATION. r_0	r_1	r_2	r_3
8 x 6	½	23.0	1.47	1.79	3.56	3.69	3.83
8¼ x 6¼	1	45.6	1.72	1.77	3.71	3.85	4.00
7 x 3½	½	17.0	0.78	0.93	3.38	3.53	3.67
7¼ x 3¾	1	32.5	1.02	0.93	3.56	3.70	3.85
6½ x 4	⅜	12.9	0.90	1.15	3.00	3.14	3.28
6⅞ x 4⅜	15/16	31.9	1.20	1.17	3.24	3.38	3.53
6 x 4	⅜	12.2	0.94	1.17	2.74	2.87	3.01
6⅜ x 4⅜	15/16	29.4	1.24	1.18	2.96	3.11	3.26
6 x 3½	⅜	11.6	0.79	0.99	2.81	2.95	3.10
6⅜ x 3⅞	15/16	28.6	1.08	0.95	3.04	3.18	3.33
5½ x 3½	⅜	11.0	0.82	1.01	2.54	2.68	2.82
5¾ x 3¾	⅝	17.9	0.97	1.03	2.66	2.80	2.95
5 x 4	⅜	11.0	1.03	1.20	2.21	2.34	2.48
5 3/16 x 4 3/16	¾	21.3	1.21	1.17	2.32	2.46	2.61
5 x 3½	5/16	8.7	0.84	1.03	2.25	2.39	2.53
5¼ x 3¾	¾	20.0	1.06	1.03	2.41	2.56	2.71
5 x 3	5/16	8.2	0.68	0.85	2.33	2.47	2.62
5¼ x 3¼	¾	18.7	0.90	0.86	2.49	2.64	2.79
4½ x 3	5/16	7.7	0.71	0.87	2.06	2.19	2.34
4¾ x 3¼	¾	17.4	0.94	0.87	2.22	2.37	2.52

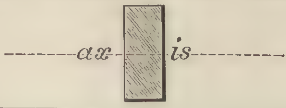
RADII OF GYRATION FOR 2 ANGLES WITH SIDES PARALLEL.

The radii of gyration correspond to axes shown.



Size in Inches.	Thickness.	Weight per Foot in Pounds.	*d*	RADII OF GYRATION.			
				r_0	r_1	r_2	r_3
4 x 3½	$\frac{5}{16}$	7.7	0.93	1.07	1.73	1.86	2.00
4¼ x 3¾	¾	17.4	1.15	1.07	1.88	2.03	2.18
4 x 3	$\frac{5}{16}$	7.1	0.76	0.89	1.79	1.92	2.07
4⅛ x 3⅛	⅝	13.8	0.90	0.80	1.88	2.02	2.17
3½ x 3	$\frac{5}{16}$	6.6	0.81	0.91	1.53	1.66	1.81
3$\frac{13}{16}$ x 3$\frac{5}{16}$	⅝	12.9	1.00	0.95	1.68	1.82	1.98
3½ x 2½	¼	4.9	0.61	0.74	1.58	1.71	1.86
3¾ x 2¾	½	9.4	0.76	0.77	1.71	1.85	2.00
3½ x 2	¼	4.5	0.46	0.56	1.65	1.80	1.95
3⅝ x 2⅛	⅜	6.6	0.53	0.57	1.71	1.85	2.00
3 x 2½	¼	4.5	0.67	0.75	1.31	1.45	1.60
3¼ x 2¾	½	8.7	0.80	0.80	1.44	1.58	1.73
3 x 2	¼	4.1	0.49	0.58	1.38	1.52	1.67
3¼ x 2¼	½	7.9	0.64	0.61	1.51	1.66	1.81
2½ x 2	$\frac{3}{16}$	2.7	0.51	0.60	1.10	1.23	1.38
2$\frac{13}{16}$ x 2$\frac{5}{16}$	½	7.0	0.69	0.66	1.27	1.41	1.56
2¼ x 1½	$\frac{3}{16}$	2.3	0.37	0.42	1.03	1.17	1.33
2$\frac{7}{16}$ x 1$\frac{11}{16}$	⅜	4.4	0.48	0.46	1.13	1.28	1.43
2 x 1½	$\frac{3}{16}$	2.1	0.39	0.44	0.90	1.04	1.19
2$\frac{3}{16}$ x 1$\frac{11}{16}$	⅜	4.3	0.50	0.48	0.99	1.14	1.30
2 x 1¼	$\frac{3}{16}$	1.9	0.31	0.35	0.94	1.09	1.24
2$\frac{3}{16}$ x 1$\frac{7}{16}$	⅜	3.9	0.42	0.38	1.03	1.18	1.34

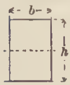
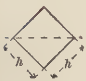
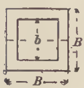
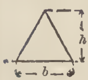
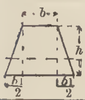
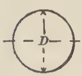
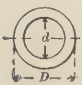
MOMENT OF INERTIA OF RECTANGLES.



Depth in Inches.	Width of Rectangle in Inches.						
	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
6	4.50	5.63	6.75	7.88	9.00	10.13	11.25
7	7.15	8.93	10.72	12.51	14.29	16.08	17.86
8	10.67	13.33	16.00	18.67	21.33	24.00	26.67
9	15.19	18.98	22.78	26.58	30.38	34.17	37.97
10	20.83	26.04	31.25	36.46	41.67	46.87	52.08
11	27.73	34.66	41.59	48.53	55.46	62.39	69.32
12	36.00	45.00	54.00	63.00	72.00	81.00	90.00
13	45.77	57.21	68.66	80.10	91.54	102.98	114.43
14	57.17	71.46	85.75	100.04	114.33	128.63	142.92
15	70.31	87.89	105.47	123.05	140.63	158.20	175.78
16	85.33	106.67	128.00	149.33	170.67	192.00	213.33
17	102.35	127.94	153.53	179.12	204.71	230.30	255.89
18	121.50	151.88	182.25	212.63	243.00	273.38	303.75
19	142.90	178.62	214.34	250.07	285.79	321.52	357.24
20	166.67	208.33	250.00	291.67	333.33	375.00	416.67
21	192.94	241.17	289.41	337.64	385.88	434.11	482.34
22	221.83	277.29	332.75	388.21	443.67	499.13	554.58
23	253.48	316.85	380.22	443.59	506.96	570.33	633.70
24	288.00	360.00	432.00	504.00	576.00	648.00	720.00
25	325.52	406.90	488.28	569.66	651.04	732.42	813.80
26	366.17	457.71	549.25	640.79	732.33	823.88	915.42
27	410.06	512.58	615.09	717.61	820.13	922.64	1025.16
28	457.33	571.67	686.00	800.33	914.67	1029.00	1143.33
29	508.10	635.13	762.16	889.18	1016.21	1143.23	1270.26
30	562.50	703.13	843.75	984.38	1125.00	1265.63	1406.25
31	620.65	775.81	930.97	1086.13	1241.30	1396.46	1551.62
32	682.67	853.33	1024.00	1194.67	1365.33	1536.00	1706.67
33	748.69	935.86	1123.03	1310.20	1497.38	1684.55	1871.72
34	818.83	1023.54	1228.25	1432.96	1637.67	1842.38	2047.08
35	893.23	1116.54	1339.84	1563.15	1786.46	2009.76	2233.07
36	972.00	1215.00	1458.00	1701.00	1944.00	2187.00	2430.00
37	1055.27	1319.09	1582.90	1846.72	2110.54	2374.35	2638.17
38	1143.17	1428.96	1714.75	2000.54	2286.33	2572.13	2857.92
39	1235.81	1544.77	1853.72	2162.67	2471.62	2780.58	3089.53
40	1333.33	1666.67	2000.00	2333.33	2666.67	3000.00	3333.33

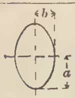
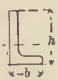
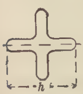
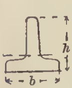
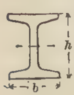
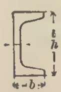
ELEMENTS OF USUAL SECTIONS.

Moments refer to horizontal axis as shown. This table is intended for convenient application where extreme accuracy is not important. Some of the terms are only approximate; those marked * are correct. Values for radius of gyration in flanged beams apply to standard minimum sections only. A = area of section.

Shape of Section.	*Moment of Inertia.*	*Moment of Resistance.*	*Distance of Base from Centre of Gravity.*	*Least Radius of Gyration.*
	$\frac{bh^3}{12}$ *	$\frac{bh^2}{6}$ *	$\frac{h}{2}$	$\frac{\text{Least Side}}{3.46}$ *
	$\frac{h^4}{12}$ *	$0.1178h^3$ *		$\frac{h}{3.46}$ *
	$\frac{B^4 - b^4}{12}$ *	$\frac{1}{6}\frac{B^4 - b^4}{B}$ *	$\frac{B}{2}$	$\sqrt{\frac{B^2 + b^2}{12}}$ *
	$\frac{bh^3}{36}$ *	$\frac{bh^2}{24}$ *	$\frac{2}{3}$ h	The least of the two: $\frac{h}{4.24}$ or $\frac{b}{4.9}$ *
	$\frac{bh^3}{12}$ *			
	$\frac{6b^2 + 6bb_1 + b_1^2}{36\,(2b + b_1)}h^3$ *		$\frac{1}{3}\frac{3b + b_1}{2b + b_1}h$	
	$\frac{AD^2}{16}$ *	$\frac{AD}{8}$ *	$\frac{D}{2}$	$\frac{D}{4}$ *
	$0.0491\,(D^4 - d^4)$ *	$0.0982\frac{D^4 - d^4}{D}$ *	$\frac{D}{2}$	$\frac{1}{4}\sqrt{(D^2 + d^2)}$ *

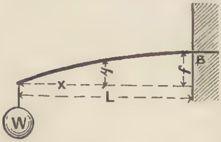
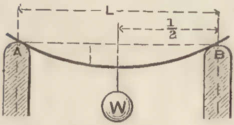
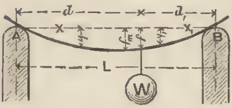
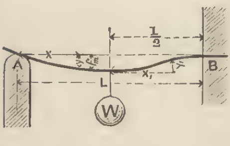
ELEMENTS OF USUAL SECTIONS.

Moments refer to horizontal axis as shown. This table is intended for convenient application where extreme accuracy is not important. Some of the terms are only approximate ; those marked * are correct. Values for radius of gyration in flanged beams apply to standard minimum sections only. A = area of section.

Shape of Section.	*Moment of Inertia.*	*Moment of Resistance.*	*Distance of Base from Centre of Gravity.*	*Least Radius of Gyration.*
	$0.1098\, r^4$ *	$W_1 = 0.1908\, r^3$* $W_2 = 0.2587\, r^3$	$0.4244\, r$	$0.0699\, r^2$ *
	$0.7854\, ba^3$ *	$0.7854\, ba^2$ *		
	$\frac{Ah^2}{10.4}$	$\frac{Ah}{7.4}$	$\frac{h}{3.5}$	$\frac{h}{5}$
	$\frac{Ah^2}{9.9}$	$\frac{Ah}{6.7}$	$\frac{h}{3.1}$	$\frac{hb}{2.6\,(h+b)}$
	$\frac{Ah^2}{19}$	$\frac{Ah}{9.5}$	$\frac{h}{2}$	$\frac{h}{4.74}$
	$\frac{Ah^2}{10.9}$	$\frac{Ah}{7.6}$	$\frac{h}{3.3}$	$\frac{b}{4.66}$
	$\frac{Ah^2}{6.1}$	$\frac{Ah}{3.0}$	$\frac{h}{2}$	$\frac{b}{5.2}$
	$\frac{Ah^2}{6.73}$	$\frac{Ah}{3.3}$	$\frac{h}{2}$	$\frac{b}{3.56}$

BENDING MOMENTS, DEFLECTIONS, ETC.,

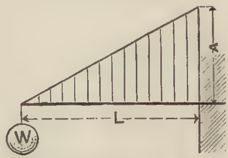
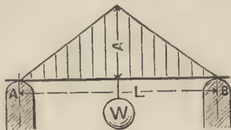
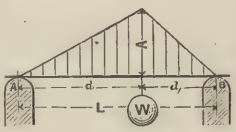
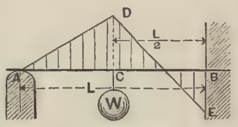
W = Total load. L = Length of beam.
E = Modulus of elasticity. I = Moment of inertia.

Form of Support and Load.	*Reactions A. B. Safe Load W.*	*Bending Moment M.*
	$B = W$ $W = \frac{KR}{L}$	$M = Wx$ $M \text{ max.} = WL$
	$A = B = \frac{W}{2}$ $W = 4\ \frac{KR}{L}$	$M = \frac{Wx}{2}$ $M \text{ max.} = \frac{WL}{4}$
	$A = \frac{Wd_1}{L}$ $B = \frac{Wd}{L}$ $W = KR\ \frac{L}{dd_1}$	For AD, $M = \frac{Wd_1 x}{L}$ For BD, $M = \frac{Wd\,x_1}{L}$ $M \text{ max.} = \frac{Wd\,d_1}{L}.$
	$A = \frac{5}{16}\ W$ $B = \frac{11}{16}\ W$ $W = \frac{16}{3}\ \frac{KR}{L}$	For AD, $M = \frac{5}{16}\ Wx.$ For BD, $M = WL\ \left(\frac{5}{32} - \frac{11}{16}\frac{x_1}{L}\right).$ $M \text{ max.} = \frac{3}{16}\ WL.$ $M_d = \frac{5}{32}\ WL.$

FOR BEAMS OF UNIFORM SECTION.

$R = \frac{I}{c}$ = Resisting moment. K = Fibre stress.

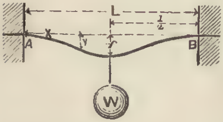
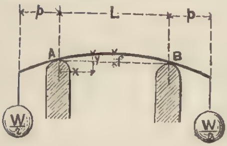
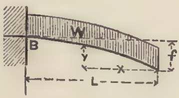
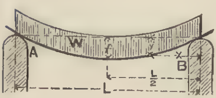
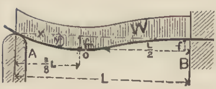
c = Distance from neutral axis to extreme fibres.

Equation of Elastic Curve.	*Deflection "f."*	*Graphical Method, Ordinates give Bending Moments.*
$y = \frac{WL^3}{2EI}\left[\frac{x}{L} - \frac{1}{3}\frac{x^3}{L^3}\right]$	$f = \frac{W}{3}\frac{L^3}{EI}$	 Draw triangle $A - WL$.
$y = \frac{WL^3}{16\,EI}\left[\frac{x}{L} - \frac{4}{3}\frac{x^3}{L^3}\right]$	$f = \frac{W}{48}\frac{L^3}{EI}$	 Draw triangle $A = \frac{WL}{4}$.
$y = \frac{W\,d^2 d_1^{\,2}}{6\;LEI}\left[2\frac{x}{d} + \frac{x_1}{d_1} - \frac{x^3}{d^2 d_1}\right]$ $y_1 = \frac{W\,d^2 d_1^{\,2}}{6\;LEI}\left[\frac{2x_1}{d_1} + \frac{x_1}{d} - \frac{x_1^{\,3}}{d_1^{\,2} d}\right]$	$f = \frac{1}{27}\,W d d_1 \frac{d_1 + L}{EIL}\sqrt{d(d_1+L)}$ f max. for $x = d\sqrt{\frac{1}{3} + \frac{2d_1}{3d}}$ $(d > d_1)$ $x_1 = d_1\sqrt{\frac{1}{3} + \frac{2d}{3d_1}}$ $(d < d_1)$	 Draw triangle $A = \frac{Wab}{L}$.
$y = \frac{W}{32}\frac{L^3}{EI}\left[\frac{x}{L} - \frac{5}{3}\frac{x^3}{L^3}\right]$ $y_1 = \frac{W}{32}\frac{L^3}{EI} \times$ $\left[\frac{1}{4}\frac{x_1}{L} + \frac{5}{2}\frac{x_1^{\,2}}{L^2} - \frac{11}{3}\frac{x_1^{\,3}}{L^3}\right]$	$f = \frac{7}{768}\frac{WL^3}{EI}$. f max. $= \sqrt{\frac{1}{5}} \times \frac{PL^3}{48\,EI}$. *for* $x = L\sqrt{\frac{1}{5}}$	 Draw triangles $BE = \frac{3}{16}WL$, $CD = \frac{5}{32}WL$.

BENDING MOMENTS, DEFLECTIONS, ETC.,

W = Total Load. L = Length of beam.

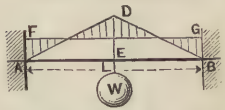
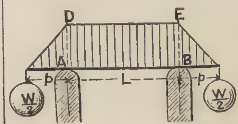
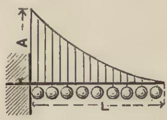
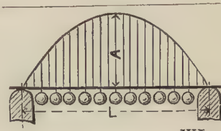
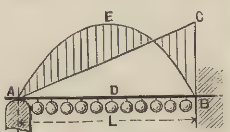
E = Modulus of elasticity. I = Moment of inertia.

Form of Support and Load.	*Reactions A. B. Safe Load W.*	*Bending Moment M.*
	$A = B = \frac{W}{2}$ $W = 8\frac{KR}{L}$	$M = \frac{WL}{2}\left(\frac{x}{L} - \frac{1}{4}\right)$ $M \text{ max.} = \frac{WL}{8}$
	$A = B = \frac{W}{2}$ $W = 2\frac{KR}{p}$	For A and B $M = \frac{Wp}{2}$
	$B = W$ $W = 2\frac{KR}{L}$	$M = \frac{Wx^2}{2L}$ $M \text{ max.} = \frac{WL}{2}$
	$A = B = \frac{W}{2}$ $W = 8\frac{KR}{L}$	$M = \frac{Wx}{2}\left(1 - \frac{x}{L}\right)$ $M \text{ max.} = \frac{WL}{8}$
	$A = \frac{3}{8}W$ $B = \frac{5}{8}W$ $W = 8\frac{KR}{L}$	$M = \frac{Wx}{2}\left(\frac{3}{4} - \frac{x}{L}\right)$ $M \text{ max.} = \frac{WL}{8}$ $M_o = \frac{9}{128}WL$

FOR BEAMS OF UNIFORM SECTION.

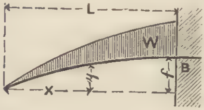
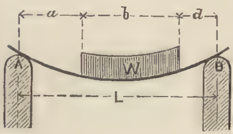
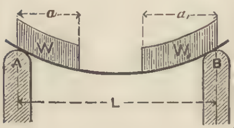
$R=\frac{I}{c}=$ Resisting moment. $K=$ Fibre stress.

$c=$ Distance from neutral axis to extreme fibres.

Equation of Elastic Curve.	*Deflection "f."*	*Graphical Method. Ordinates give Bending Moments.*
$y=\frac{W}{16}\frac{L^3}{EI}\times\left[\frac{x^2}{L^2}-\frac{4}{3}\frac{x^3}{L^3}\right]$	$f=\frac{W}{192}\frac{L^3}{EI}$	 Draw triangle and rectangle $ED=\frac{WL}{4}, AF=\frac{WL}{8}$.
$y=f-p+\sqrt{p^2-x^2+L\left(x-\frac{L}{4}\right)}$ $p=\frac{2EI}{Wp}=$ const.	$f=\frac{WL^2p}{16\,EI}$	 Draw trapezoid $DA=\frac{Wp}{2}$.
$y=\frac{W}{24}\frac{L^3}{EI}\times\left[4\frac{x}{L}-\frac{x^4}{L^4}-3\right]$	$f=\frac{W}{8}\frac{L^3}{EI}$	 Draw parabola $A=\frac{WL}{2}$.
$y=\frac{W}{24}\frac{L^3}{EI}\times\left[\frac{x}{L}-2\frac{x^3}{L^3}+\frac{x^4}{L^4}\right]$	$f=\frac{5}{384}\frac{WL^3}{EI}$	 Draw parabola $A=\frac{WL}{8}$.
$y=\frac{W}{48}\frac{L^3}{EI}\times\left[\frac{x}{L}-3\frac{x^3}{L^3}+2\frac{x^4}{L^4}\right]$	Inflection at $\frac{3}{4}L$ $f=\frac{WL^3}{192\,EI}$ Max. Deflect. $x=0.4215\,L$	 Draw triangle and parabola $CB=DE=WL^2:8$.

BENDING MOMENTS, DEFLECTIONS, ETC.,

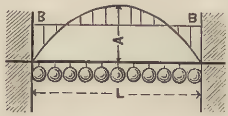
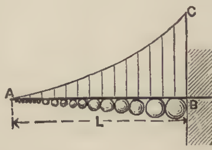
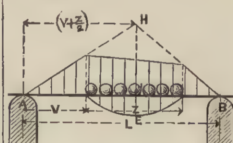
W = Total load. L = Length of beam.
E = Modulus of elasticity. I = Moment of inertia.

Form of Support and Load.	*Reactions A. B. Safe Load W.*	*Bending Moment M.*
	$A = B = \frac{W}{2}$ $W = 12\frac{KR}{L}$	$M = \frac{WL}{2}\left(\frac{1}{6} - \frac{x}{L} + \frac{x^2}{L^2}\right)$ $M \text{ max.} = \frac{WL}{12}$ $M_o. = \frac{WL}{24}$
	$B = W$ $W = 3\frac{KR}{L}$	$M = \frac{W}{3}\frac{x^3}{L^2}$ $M \text{ max.} = \frac{WL}{3}$
	$A = \frac{W(2d+b)}{2L}$ $B = \frac{W(2a+b)}{2L}$	$RK = A\left(a + \frac{b}{2}\frac{A}{W}\right)$
	$A = \frac{W(2L - a)}{2L} + \frac{W_1 a_1}{2L}.$ $B = \frac{W_1(2L - a_1)}{2L} + \frac{Wa}{2L}.$	For $A < W$ $RK = \frac{A^2 a}{2W}$ For $B < W_1$ $RK = \frac{B^2 a_1}{2W_1}$ For $W = W_1$ and $a = a_1$ $RK = \frac{1}{2}Wa.$

FOR BEAMS OF UNIFORM SECTION.

$R = \frac{I}{c} =$ Resisting moment. $K =$ Fibre stress.

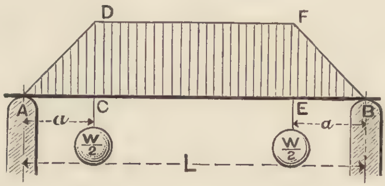
$c =$ Distance from neutral axis to extreme fibres.

Equation of Elastic Curve.	*Deflection "f."*	*Graphical Method. Ordinates give Bending Moments.*
$y = \frac{WL^3}{24\,EI}\left[\frac{x^2}{L^2} - \frac{2x^3}{L^3} + \frac{x^4}{L^4}\right]$	$f = \frac{WL^3}{384\,EI}$ Point of Inflection $x = 0.2113\,L.$	 Draw parabola and rectangle, $A = \frac{WL}{8}$ $BC = \frac{WL}{12}.$
$y = \frac{WL^3}{12\,EI}\left[\frac{x}{L} - \frac{1}{5}\frac{x^5}{L^5}\right]$	$f = \frac{WL^3}{15\,EI}$	 Draw parabola, $BC = \frac{WL}{3}.$
		 Draw triangle and parabola, $KH = \frac{WZab}{L}$ $KE = \frac{WZ^2}{8}$

BENDING MOMENTS, DEFLECTIONS, ETC., FOR BEAMS OF UNIFORM SECTIONS.

$W =$ Total load. $L =$ Length of beam.
$E =$ Modulus of elasticity. $I =$ Moment of inertia.
$R = \frac{I}{c} =$ Resisting moment. $K =$ Fibre stress.
$c =$ Distance from neutral axis to extreme fibres.

Beam supported at both ends, 2 symmetrical loads.



$AC = EB =$ Distance from support to load. Draw trapezoid having $CD = EF = \frac{1}{2}\,Wa$. Ordinates give bending moments for corresponding positions on beam.

Bending moment between loads $= \frac{1}{2}\,Wa$.

Maximum deflection $= \frac{Wa}{48\,EI}(3\,L^2 - 4a^2)$.

Beam supported at both ends, with concentrated loads at various points:

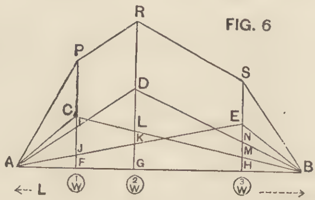


FIG. 6

Draw (by 3, page 221) the triangles having vertices at C, D and E, the verticals representing bending moments for loads w^1, w^2 and w^3, respectively. Extend FC to P, GD to R, and HE to S, making each long vertical equal to the sum of the bending moments corresponding to its position. That is, $FP = FC + FI + FJ$, $GR = GD + GL + GK$. And $HS = HE + HN + HM$. Verticals drawn from any point on the polygon, $APRSB$ to AB, will represent the bending moments at the corresponding points on the beam.

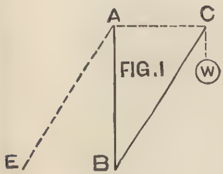
STRESSES IN SOME SIMPLE FORMS OF FRAMED STRUCTURES.

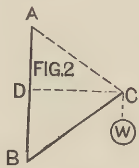
Compression indicated by the sign — and by solid lines. Tension by the sign + and by dotted lines.

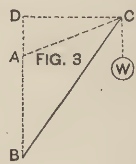
When the prefix "stress" is used, the load borne by the member is indicated; otherwise the length of the member is meant.

CRANES.

Supported at the points A and B, maximum longitudinal stresses, due to weight W, suspended at the end. These stresses are modified by the position of the hoisting chain.







D is the point where a line drawn from C at right angles to $A\,B$ will intersect the latter.

Stress $A\,C = +\dfrac{A\,C}{A\,B} \times W$ Stress $B\,C = \dfrac{B\,C}{A\,B} \times W$

" $A\,B = -\dfrac{A\,D}{A\,B} \times W$ in Fig. 2, or $= +\dfrac{A\,D}{A\,B} \times W$ in Fig. 3.

When point A is supported by inclined back stays as shown in Fig. 1, and when the back stay is in the plane of $A\,B$ and W.

$$\text{Stress } A\,E = +\frac{A\,C}{A\,B} \times W \times \frac{A\,E}{E\,B},$$

and a resulting compression ensues on

$$A\,B = -\frac{A\,C}{A\,B} \times W \times \frac{A\,B}{B\,E}.$$

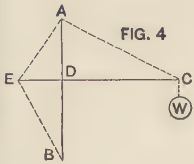


FIG. 4

$$\text{Stress } C\,D = -\frac{C\,D}{A\,D} \times W$$

$$\text{"}\quad A\,C = +\frac{A\,C}{A\,D} \times W$$

$$\text{"}\quad E\,D = -\text{ stress } D\,C.$$

Let w = the horizontal reaction at B

$$w = \frac{C\,D}{A\,B} \times W$$

$$\text{Stress } B\,E = +\frac{B\,E}{E\,D} \times w$$

$$\text{"}\quad A\,E = +\frac{A\,E}{D\,E} \times (\text{stress } C\,D - w)$$

$$\text{"}\quad B\,A = -\left(\frac{B\,D}{D\,E} \times w + W\right)$$

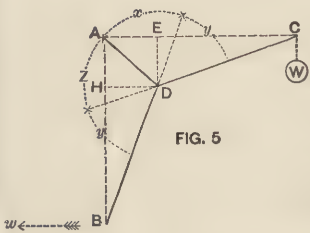


FIG. 5

E and H are points where lines drawn from D intersect at right angles $A\,C$ and $A\,B$. X, Y and Z are the angles formed by extending the braces $C\,D$ and $B\,D$ as indicated by dotted lines. w = the horizontal reaction at B

$$w = \frac{A\,C}{A\,B} \times W.$$

$$\text{Stress } A\,C = +\frac{C\,E}{E\,D} \times W. \quad \text{Stress } C\,D = -\frac{C\,D}{E\,D} \times W$$

$$\text{"}\quad A\,B = +\frac{B\,H}{D\,H} \times w. \quad \text{"}\quad B\,D = -\frac{B\,D}{H\,D} \times w$$

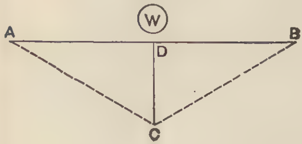
$$A\,D = -\text{ stress } C\,D \times \frac{\text{Sine } Y}{\text{Sine } X}$$

$$\text{or} = -\text{ stress } B\,D \times \frac{\text{Sine } Y}{\text{Sine } Z}$$

Trussed Girders.

Weight in Middle.

FIG. 6



Stress $A\,C$ or

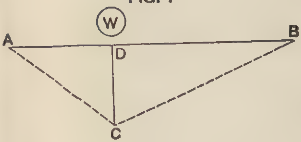
$$B\,C = +\frac{A\,C}{D\,C} \times \frac{W}{2}$$

" $$A\,B = -\frac{A\,D}{D\,C} \times \frac{W}{2}$$

" $$D\,C = -\,W$$

Weight out of Centre.

FIG. 7



Stress $A\,C = +\dfrac{A\,C \times D\,B}{A\,B \times D\,C} \times W$

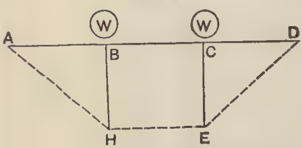
" $B\,C = +\dfrac{B\,C \times A\,D}{A\,B \times C\,D} \times W$

Stress $A\,B = -\dfrac{A\,D \times D\,B}{A\,B \times D\,C} \times W$

" $D\,C = -\,W$

Equal Loads W. W.

FIG. 8



Stress $A\,H$ or $D\,E = +\dfrac{A\,H}{B\,H} \times W$

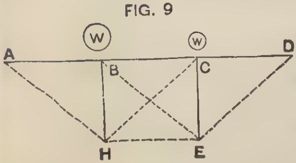
" $H\,E = +\dfrac{A\,B}{B\,H} \times W$

" $A\,D = -\dfrac{A\,B}{B\,H} \times W$

Stress $B\,H$ or $C\,E = -\,W$

Unequal Loads W and w.

FIG. 9

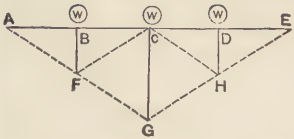


Stress as below on counter diagonals $B\,E$ or $H\,C$ according to position of greatest load.

Stress $C\,H = +\dfrac{C\,H}{B\,H} \times \left(\dfrac{W - w}{3}\right)$

Fink Truss.

FIG. 10



Stress BF or $DH = -W$

" $CG = -2\,W$

" $AE = -1\frac{1}{2}\,W \times \frac{AC}{CG}$

Stress AF or $HE = +1\frac{1}{2}\,W \times \frac{AF}{FB}$

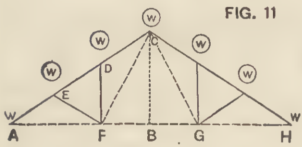
" FG or $HG = +\,W \times \frac{AG}{CG}$

FC or $CH = +\frac{W}{2} \times \frac{AG}{CG}$

Roofs.

$w =$ load concentrated on each triangular apex.

FIG. 11



Strut Stresses.

Stress $DF = -w$

" $EF = \frac{w}{2} \times \frac{CH}{CB}$

Stresses on Ties.

Stress $FG = +1\frac{1}{2}\,w \times \frac{BH}{BC}$

" $AF = +2\frac{1}{2}\,w \times \frac{BH}{BC}$

" $CF = +1\frac{1}{2}\,w \times \frac{CG}{BC}$

Rafter Stresses.

Stress $CE = -2\,w \times \frac{CH}{CB}$

" $EA = -2\frac{1}{2}\,w \times \frac{CH}{CB}$

$w =$ load concentrated on each triangular apex.

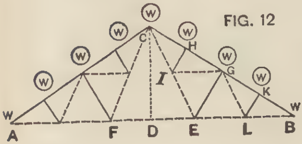


FIG. 12

Strut Stresses.

$$\text{Stress } HI \text{ or } KL = -w \times \frac{DB}{CB}$$

$$\text{" } GE = -2w \times \frac{DB}{CB}$$

Rafter Stresses.

$$\text{Stress } KB = -\left(\frac{7w}{2} \times \frac{CB}{CD}\right)$$

$$\text{" } GK = -\left(\frac{7w}{2} \times \frac{CB}{CD} - w \times \frac{CD}{CB}\right)$$

$$\text{" } HG = -\left(\frac{7w}{2} \times \frac{CB}{CD} - 2w \times \frac{CD}{CB}\right)$$

$$\text{" } CH = -\left(\frac{7w}{2} \times \frac{CB}{CD} - 3w \times \frac{CD}{CB}\right)$$

Stresses on Ties.

$$\text{Stress } GI \text{ or } GL = +\frac{w}{2} \times \frac{DB}{CB} \times \frac{CB}{CD}$$

$$\text{" } EI = +w \times \frac{DB}{CB} \times \frac{CB}{CD}$$

$$\text{" } CI = +\frac{3w}{2} \times \frac{DB}{CB} \times \frac{CB}{CD}$$

$$\text{" } FE = +\frac{8w}{4} \times \frac{DB}{DC}$$

" $EL =$ the sum of the stresses on FE and EI.

" $LB =$ the sum of the stresses on EL and GL.

$w =$ load concentrated on each triangular apex.

The rafters and horizontal tie being each uniformly subdivided.

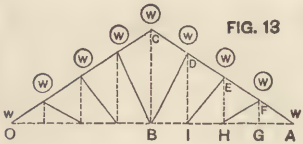


FIG. 13

Strut Stresses.

Stress $FH = -\frac{w}{2} \times \frac{FH}{FG}$

" $EI = -w \times \frac{EI}{EH}$

" $DB = -\frac{3w}{2} \times \frac{DB}{DI}$

Vertical Ties.

Stress $EH = +\frac{w}{2}$. Stress $DI = +w$. Stress $CB = +3w$.

Rafter Stresses.

Stress $CD = -2\ w \times \frac{CA}{CB}$

" $DE = -2\frac{1}{2}\ w \times \frac{CA}{CB}$

" $EF = -3\ w \times \frac{CA}{CB}$

" $FA = -3\frac{1}{2}\ w \times \frac{CA}{CB}$

Horizontal Tie.

Stress at $B = +2\ w \times \frac{BA}{BC}$

" $BI = +$ stress at $B + \left(\text{stress } DB \times \frac{BI}{BD}\right)$

" $IH = +$ " $BI + \left(\text{ " } EI \times \frac{HI}{EI}\right)$

" $HA = +$ " $IH + \left(\text{ " } FH \times \frac{HG}{HF}\right)$

ROOFS.

Iron roofs having a slope of 2 to 1, and trusses about 15 feet apart, will approximate in weight as follows per square foot of building area:

Weight of material in frame, including truss and purlins, but not covering:

Truss of	75 to 100 feet span,	8 to 10	pounds per sq. ft.
" "	50 to 75 "	7 to 8	" " "
"	under 50 "	5 to 7	" " "

To this must be added the following weights of covering material per square foot of building area:

Tin on 1″ boards	4.5	pounds.
Corrugated sheets, No. 20, galvanized	2.3	"
" " No. 20, " on 1″ boards	5.7	"
Slate $\frac{3}{16}$″ thick, on $1\frac{1}{4}$″ boards	11.0	"
" $\frac{1}{8}$″ " " 1 "	7.5	"
Felt and gravel	9–11	"
If plastered below rafters, add	10	"

The snow load will vary with the latitude from 10 pounds per square foot of building area for Baltimore and Cincinnati to 30 pounds for Northern New England. In roofs with inclinations of 45 degrees or over the snow load can be neglected if no snow guards or other obstructions are attached. On slate roofs with a slope of 2 horizontal to 1 vertical, the snow will not accumulate to any material thickness.

The normal wind load is usually computed by Hutton's formula $u' = u \sin \propto ^{1.84 \cos \propto \,-1}$ where $u' =$ pressure due to wind normal to roof surface $u =$ horizontal pressure of wind in pounds per square foot, $\propto =$ inclination of the roof to the horizontal in degrees.

Taking the horizontal pressure at 30 pounds per square foot we derive the following normal pressure per square foot of roof surface:

Inclination.	Pressure.	Inclination.	Pressure.	Inclination.	Pressure.
5°	3.9 lbs.	25°	16.9 lbs.	45°	27.1 lbs.
10°	7.2 "	30°	19 9 "	50°	28.6 "
15°	10.5 "	35°	22.6 "	55°	29.7 "
20°	13.7 "	40°	25.1 "	60°	30.0 "

SHAFTING OF STEEL OR WROUGHT IRON.

The resistance to shearing averages about $\frac{8}{10}$ of the tensile strength, *i. e.* about 40,000 lbs. for wrought iron, or 50,000 lbs. for soft steel, per square inch of section.

The torsional resistance of any shaft can be determined when the shearing resistance is known; thus

$$T = .196\, d^3 s \text{ for round shafts,} \qquad (a)$$

$$T = .28\, d^3 s \text{ for square shafts.} \qquad (b)$$

d = diameter of the shaft in inches.

s = shearing strength in pounds per square inch.

T = the torsional moment in inch-pounds; that is, the force in pounds multiplied by the length in inches of the lever through which the force acts.

Taking s at 40,000 and 50,000 lbs., respectively for iron and steel, and assuming that in machinery the working value should be between one-fourth and one-fifth of the ultimate strength—adopting the mean—makes the working resistance to shearing 9,000 lbs. per square inch for iron, and 11,200 lbs. per square inch for steel. Putting this in terms of the torsional moment and diameter, we derive from equations a and b

$$T = 1760\, d^3 \text{ for round iron shafts,} \qquad (c)$$

$$T = 2200\, d^3 \text{ for round steel shafts,} \qquad (d)$$

$$T = 2520\, d^3 \text{ for square iron shafts,} \qquad (e)$$

$$T = 3150\, d^3 \text{ for square steel shafts,} \qquad (f)$$

$$d = \sqrt[3]{\frac{T}{1760}} \text{ for round iron shafts,} \qquad (g)$$

$$d = \sqrt[3]{\frac{T}{2200}} \text{ for round steel shafts,} \qquad (h)$$

$$d = \sqrt[3]{\frac{T}{2520}} \text{ for square iron shafts,} \qquad (i)$$

$$d = \sqrt[3]{\frac{T}{3150}} \text{ for square steel shafts,} \qquad (k)$$

These formulæ apply to shafts subject to twisting strains alone. In practice, however, such cases seldom occur, as shafts are generally subjected to combined bending and twisting strains. As there are no experimental data for

such a combination of forces, we have to rely on analysis, which gives the following:

$$T^1 = M + \sqrt{M^2 + T^2} \qquad (l)$$

M = bending moments in inch-pounds. (See page 220.)
T = twisting " "
T^1 = a *new* twisting moment which, substituted for T in equations g to k, will give the desired proportions for the shaft.

In revolving shafts the longitudinal stress resulting from the bending action is continually changing from tension to compression, and vice versa.

It is therefore advisable, for reasons given on page 22, to increase the factor of safety as the bending stress increases comparatively to the torsional stress.

The following changes in factors of safety are recommended:

Ratio of M to T.	*Factor of Safety.*	*Divisor in Formulæ.*	
		(g) *for Iron.*	(h) *for Steel.*
$M = .3T$ or less,	$4\frac{1}{2}$	1760	2200
$M = .6T$ "	5	1570	1960
$M = T$ "	$5\frac{1}{2}$	1430	1790
M = greater than T,	6	1310	1640

HORSE-POWER.

If it is desired to find the relations between horse-power and diameters of shafts, the elements of time and velocity have to be considered. Taking the horse-power HP at 396,000 inch-lbs. per minute, we have $HP = \frac{628 \times T \times V}{396{,}000}$, where V = revolutions per minute.

$$T = \frac{63{,}057\ HP}{V}, \qquad (m)$$

or in terms of the diameter by equation (d) we get for shafts of medium steel

$$d = \sqrt[3]{\frac{29\ HP}{V}}. \qquad (o)$$

The above will give the proper diameter of a shaft for transmitting any desired *HP* when the shaft is subjected to twisting stress alone ; but since, as previously stated, such a case seldom occurs, we must combine the bending and twisting stresses, for which a general rule will be given at the close of the subject.

DEFLECTION OF SHAFTING.

As the deflection of steel and iron is practically alike under similar conditions of dimensions and loads, and as shafting is usually determined by its transverse stiffness rather than its ultimate strength, it follows that nearly the same dimensions should be used for steel that are found necessary for iron.

For continuous line shafting used for transmitting power in shops, factories, etc., it is considered good practice to limit the deflection to a maximum of $\frac{1}{100}$ of an inch per foot of length. The weight of bare shafting in pounds $= 2.6\, d^2 l = W$, or when as fully loaded with pulleys as is customary in practice, and allowing 40 lbs. per inch of width for the vertical pull of the belts, experience shows the load in pounds to be about $13\, d^2 l = W$. Taking the modulus of transverse elasticity at 26,000,000 lbs., we can derive from the authoritative formulæ the following:

$$l = \sqrt[3]{873 d^2} \text{ for bare shafts} \qquad (p)$$

$$l = \sqrt[3]{175 d^2} \text{ for shafts carrying pulleys, etc.,} \qquad (r)$$

which would be the maximum distance in feet between bearings for continuous shafting subjected to bending stress alone.

If the length is fixed, and we desire the diameter of the shaft, we have,

$$d = \sqrt{\frac{l^3}{873}} \text{ for bare shafting.} \qquad (s)$$

$$d = \sqrt{\frac{l^3}{175}} \text{ for shafting carrying pulleys, etc.} \qquad (t)$$

To apply the above to revolving shafting subjected to both twisting and bending stress, it is necessary to combine equations (p) and (r) with equation (o).

But in shafting, with the same transmission of power, the torsional stress is inversely proportional to the velocity of rotation, while the bending stress will not be reduced in the same ratio. It is, therefore, impossible to write a formula covering the whole problem and sufficiently simple for practical application, but the following rules are correct within the range of velocities usual in practice.

WORKING FORMULÆ FOR CONTINUOUS SHAFTING.

For the diameter (d) in inches, and the maximum length (l) in feet between bearings of steel or iron shafting so proportioned as to deflect not more than $\frac{1}{100}$ of an inch per foot of length, allowance being made for the weakening effect of key seats,

$$d = \sqrt[3]{\frac{50\ HP}{V}} \text{ for bare shafts,} \qquad (u)$$

$$d = \sqrt[3]{\frac{70\ HP}{V}} \text{ for shafts carrying pulleys, etc.,} \qquad (v)$$

$$l = \sqrt[3]{720 d^2} \text{ for bare shafts,} \qquad (w)$$

$$l = \sqrt[3]{140\ d^2} \text{ for shafts carrying pulleys, etc.,} \qquad (x)$$

The moment of resistance of round shafts for bending is one-half of the resistance for twisting strains.

The resistances are simply and accurately expressed thus:

$$M = \frac{AD}{8} \text{ and } T = \frac{AD}{4} \text{ for solid shafts.}$$

$$M = \frac{AD^2 - ad^2}{8D} \text{ and } T = \frac{AD^2 - ad^2}{4D} \text{ for hollow shafts.}$$

D being full diameter and A corresponding area, d is the internal diameter and a corresponding area.

BELTING.

When designing shafting, allow for the tension of belting, 50 lbs. per inch of width for single leather belt or its equivalent, or 80 lbs. per inch of width for double leather belt, or its equivalent of other material.

WORKING PROPORTIONS FOR CONTINUOUS SHAFTING.

MEDIUM STEEL.

Transmitting power, but subject to no bending action except its own weight.

Diameter of Shaft in Inches.	Maximum Safe Torsional Moment in Foot Pounds.	Revolutions per Minute.					Maximum Distance in Feet Between Bearings.
		100	150	200	250	300	
		HP	HP	HP	HP	HP	
1½	618	7	10	14	17	20	11.7
1⅝	786	9	13	17	21	26	12.4
1¾	982	11	16	21	26	32	13.0
1⅞	1208	13	20	26	33	40	13.6
2	1467	16	24	32	40	48	14.2
2⅛	1758	19	29	38	48	58	14.8
2¼	2088	23	34	46	57	68	15.4
2⅜	2457	27	40	54	67	80	16.0
2½	2865	31	47	63	78	94	16.5
2¾	3896	42	62	83	102	124	17.6
3	4950	54	81	108	134	162	18.6
3¼	6293	69	103	137	172	206	19.7
3½	7860	86	129	172	215	258	20.7
3¾	9668	105	158	211	264	316	21.6
4	11733	128	192	256	320	384	22.6

WORKING PROPORTIONS FOR CONTINUOUS SHAFTING.

MEDIUM STEEL.

Transmitting power, and subject to bending action of pulleys, belting, etc.

Diameter of Shaft in Inches.	*Maximum Safe Torsional Moment in Foot-Pounds.*	*Revolutions per Minute.*					*Maximum Distance in Feet Between Bearings.*
		100	150	200	250	300	
		HP	*HP*	*HP*	*HP*	*HP*	
$1\frac{1}{2}$	618	5	7	10	12	14	6.8
$1\frac{5}{8}$	786	6	9	12	15	18	7.2
$1\frac{3}{4}$	982	8	11	15	18	22	7.5
$1\frac{7}{8}$	1208	9	14	19	23	28	7.9
2	1467	11	17	23	28	34	8.2
$2\frac{1}{8}$	1758	14	21	27	34	42	8.6
$2\frac{1}{4}$	2088	16	24	33	41	48	8.9
$2\frac{3}{8}$	2457	19	29	38	48	58	9.2
$2\frac{1}{2}$	2865	22	33	45	55	66	9.6
$2\frac{3}{4}$	3896	24	36	48	60	72	10.2
3	4950	39	58	77	96	116	10.8
$3\frac{1}{4}$	6293	49	74	98	123	148	11.4
$3\frac{1}{2}$	7860	61	92	123	153	184	12.0
$3\frac{3}{4}$	9668	75	113	151	188	226	12.5
4	11733	91	137	183	228	274	13.1

DIAMETER IN INCHES FOR ROUND STEEL SHAFTS.

PROPORTIONED FOR RESISTANCE TO TORSION, WITH THE LIMITATIONS DESCRIBED ON OPPOSITE PAGE.

Torsional Moments in Foot Pounds.	$\frac{H.P.}{R.P.M.}$	*Diameter in Inches for Conditions Described.*			*Torsional Moments in Foot Pounds.*	$\frac{H.P.}{R.P.M.}$	*Diameter in Inches for Conditions Described.*		
		No. 1.	*No. 2.*	*No. 3.*			*No. 1.*	*No. 2.*	*No. 3.*
500	.095	2.4	2.6	2.9	15000	2.855	5.7	6.2	6.8
600	.114	2.6	2.8	3.0	18000	3.425	6.0	6.5	7.1
800	.152	2.8	3.0	3.3	21000	3.996	6.2	6.7	7.4
1000	.190	2.9	3.2	3.5	25000	4.757	6.5	7.0	7.7
1200	.228	3.0	3.3	3.6	30000	5.709	6.8	7.4	8.1
1500	.286	3.2	3.5	3.8	35000	6.660	7.1	7.6	8.4
1800	.343	3.4	3.6	4.0	40000	7.612	7.3	7.9	8.7
2100	.400	3.5	3.8	4.2	45000	8.563	7.5	8.1	9.0
2500	.476	3.7	3.9	4.3	50000	9.515	7.7	8.4	9.2
3000	.571	3.8	4.1	4.6	60000	11.418	8.1	8.7	9.6
4000	.761	4.1	4.4	4.9	70000	13.321	8.4	9.1	10.0
5000	.952	4.4	4.7	5.2	80000	15.224	8.7	9.4	10.3
6000	1.142	4.6	4.9	5.4	90000	17.127	9.0	9.7	10.6
8000	1.522	4.9	5.3	5.8	100000	19.029	9.2	9.9	10.9
10000	1.903	5 2	5.6	6.1	120000	22.835	9.6	10.4	11.4
12000	2.284	5.4	5.8	6.4	150000	28.544	10.2	11.0	12.1

TORSIONAL STIFFNESS OF SHAFTS

Torsional elasticity is calculated from the following formulæ:

$$X = \frac{T\,l}{E^1\,Ip}$$

$X =$ length of arc of deflection, for a unit of length and unit radius.
$T =$ moment of torsion.
$l =$ length of shaft subject to torsion.
$Ip =$ polar moment of inertia of cross-section.
$E^1 =$ modulus of torsional shear $= \frac{4}{10}$ of the modulus of elasticity or about 11,600,000 pounds for steel shafts.

From this is obtained the angle of torsion in degrees V for each foot of length L for steel shafts of diameter "d" in inches:

$$V = \frac{T\,L}{1661\,d^4} \text{ for round shafts.}$$

$$V = \frac{T\,L}{2820\,d^4} \text{ for square shafts.}$$

The amount of torsional yield or twist permissible is obtained by experience and depends on the service to which the shaft is subjected. The following is considered good practice within the limits of length usual in ordinary practice:

PERMISSIBLE TWIST PER FOOT OF LENGTH.

No. 1. .10 degree for ordinary service, no violent fluctuations.
No. 2. .075 degree with fluctuating loads, suddenly applied.
No. 3. .050 degree when suddenly reversed under full load.

These give, when applied to the foregoing rule, for round steel shafts diameter d in inches for torsional moments T in inch pounds or for

$$\frac{H.\,P.}{R.\,P.\,M.} = \frac{\text{horse-power in foot pounds per minute}}{\text{number of revolutions per minute}}$$

No. 1. $d = .278 \sqrt[4]{T} = 4.4 \sqrt[4]{\frac{H.\,P.}{R.\,P.\,M.}}$

No. 2. $d = .30 \sqrt[4]{T} = 4.75 \sqrt[4]{\frac{H.\,P.}{R.\,P.\,M.}}$

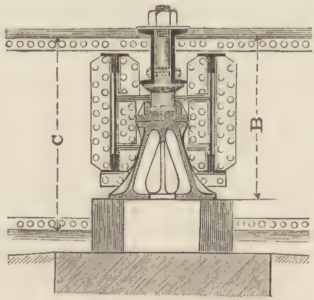
No. 3. $d = .33 \sqrt[4]{T} = 5.23 \sqrt[4]{\frac{H.\,P.}{R.\,P.\,M.}}$

The table on opposite page gives diameters for shafts corresponding to given torsion moments or power transmission, and for the three cases of limitation of twist described above.

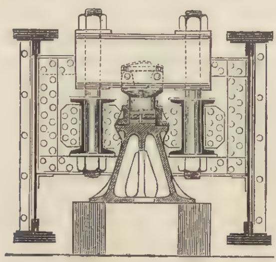
If the shaft is subjected to bending stress in addition to twisting, it should be reinforced as previously described.

PENCOYD TURNTABLES.

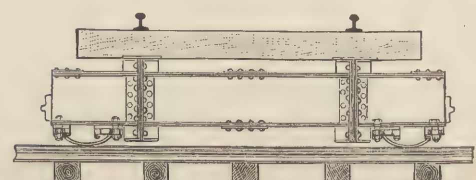
LONGITUDINAL SECTION AT CENTER.



TRANSVERSE SECTION AT CENTER.



END VIEW WITH TRUCK.



PENCOYD TURNTABLES.

The Pencoyd Standard Turntable is entirely center bearing, resting on three hardened steel discs of sufficient diameter to distribute the pressure. The discs are placed in an oil box, a steel casting, which is bolted to a cast-iron base.

The pivot is made of cast-steel and fits between the two upper cross channels, through which pass the two suspending bolts.

The four end truck wheels, which simply steady the table in turning, are made of chilled cast-iron ; these wheels should always clear the circular track rail about one inch when the table is level and unloaded, as the engine and tender should be carried entirely on the centre discs.

This turntable can be easily revolved by two men when loaded with the heaviest engine and tender.

DIMENSIONS OF PENCOYD STANDARD TURNTABLES, IN FEET AND INCHES.

				A	B		C	
Size.	*Length of girder out to out.*	*Diam. of pit.*	*Diam. of circular track.*	*Diam. of center discs.*	*Depth from top chord angles to top of center stone.*	*Depth from top chord angles to top of circular track rail.*	*Depth of Girder in center back to back of angles.*	*Total weight in lbs.*
50′	50.0	50.8	47.8⅛	7″	3.9½	2.1½	4.6½	25200
55′	55.0	5.58	52.7½	7″	3.9½	2.1½	4.6½	26800
55′ heavy	55.0	55.8	52.7½	7″	3.9½	2.1½	4.6½	28400
60′	60.0	60.8	57.7	7″	3.9½	2.1½	4.6½	34000
60′ heavy	60.0	60.8	57.7	7″	3.9½	2.1½	5.0½	37800
65′	65.0	65.8	62.6½	7″	3.9½	2.1½	4.6½	36000
65′ heavy	65.0	65.8	62.6½	8″	3.9½	2.1½	5.0½	39500
75′	75.0	75.8	72.6¼	9″	5.7⅛	3.0½	5.0	61000

MAXIMUM BENDING MOMENTS ON PINS,

WITH EXTREME FIBRE STRAINS

VARYING FROM 15,000 TO 25,000 POUNDS PER SQUARE INCH.

Diameter of Pin in Inches.	*Area of Pin in Sq. Inches.*	*Moments in Inch-Pounds for Fibre Strains of*				*Diameter of Pin in Inches.*
		15,000 *lbs. per Sq. Inch.*	20,000 *lbs. per Sq. Inch.*	22,000 *lbs. per Sq. Inch.*	25,000 *lbs. per Sq. Inch.*	
1	0.785	1470	1960	2160	2450	1
$1\frac{1}{8}$	0.994	2100	2800	3080	3500	$1\frac{1}{8}$
$1\frac{1}{4}$	1.227	2880	3830	4220	4790	$1\frac{1}{4}$
$1\frac{3}{8}$	1.485	3830	5100	5620	6380	$1\frac{3}{8}$
$1\frac{1}{2}$	1.767	4970	6630	7290	8280	$1\frac{1}{2}$
$1\frac{5}{8}$	2.074	6320	8430	9270	10500	$1\frac{5}{8}$
$1\frac{3}{4}$	2.405	7890	10500	11570	13200	$1\frac{3}{4}$
$1\frac{7}{8}$	2.761	9710	12900	14240	16200	$1\frac{7}{8}$
2	3.142	11800	15700	17280	19600	2
$2\frac{1}{8}$	3.547	14100	18800	20730	23600	$2\frac{1}{8}$
$2\frac{1}{4}$	3.976	16800	22400	24600	28000	$2\frac{1}{4}$
$2\frac{3}{8}$	4.430	19700	26300	28900	32900	$2\frac{3}{8}$
$2\frac{1}{2}$	4.909	23000	30700	33700	38400	$2\frac{1}{2}$
$2\frac{5}{8}$	5.412	26600	35500	39000	44400	$2\frac{5}{8}$
$2\frac{3}{4}$	5.940	30600	40800	44900	51000	$2\frac{3}{4}$
$2\frac{7}{8}$	6.492	35000	46700	51300	58300	$2\frac{7}{8}$
3	7.069	39800	53000	58300	66300	3
$3\frac{1}{8}$	7.670	44900	59900	65900	74900	$3\frac{1}{8}$
$3\frac{1}{4}$	8.296	50600	67400	74100	84300	$3\frac{1}{4}$
$3\frac{3}{8}$	8.946	56600	75500	83000	94400	$3\frac{3}{8}$
$3\frac{1}{2}$	9.621	63100	84200	92600	105200	$3\frac{1}{2}$
$3\frac{5}{8}$	10.321	70100	93500	102900	116900	$3\frac{5}{8}$
$3\frac{3}{4}$	11.045	77700	103500	113900	129400	$3\frac{3}{4}$
$3\frac{7}{8}$	11.793	85700	114200	125600	142800	$3\frac{7}{8}$
4	12.566	94200	125700	138200	157100	4
$4\frac{1}{8}$	13.364	103400	137800	151600	172300	$4\frac{1}{8}$
$4\frac{1}{4}$	14.186	113000	150700	165800	188400	$4\frac{1}{4}$
$4\frac{3}{8}$	15.033	123300	164400	180800	205500	$4\frac{3}{8}$
$4\frac{1}{2}$	15.904	134200	178900	196800	223700	$4\frac{1}{2}$
$4\frac{5}{8}$	16.800	145700	194300	213700	242800	$4\frac{5}{8}$
$4\frac{3}{4}$	17.721	157800	210400	231500	263000	$4\frac{3}{4}$
$4\frac{7}{8}$	18.665	170600	227500	250200	284400	$4\frac{7}{8}$
5	19.635	184100	245400	270000	306800	5
$5\frac{1}{8}$	20.629	198200	264300	290700	330400	$5\frac{1}{8}$
$5\frac{1}{4}$	21.648	213100	284100	312500	355200	$5\frac{1}{4}$
$5\frac{3}{8}$	22.691	228700	304900	335400	381100	$5\frac{3}{8}$
$5\frac{1}{2}$	23.758	245000	326700	359300	408300	$5\frac{1}{2}$
$5\frac{5}{8}$	24.850	262100	349500	384400	436800	$5\frac{5}{8}$
$5\frac{3}{4}$	25.967	280000	373300	410600	466600	$5\frac{3}{4}$
$5\frac{7}{8}$	27.109	298600	398200	438000	497700	$5\frac{7}{8}$

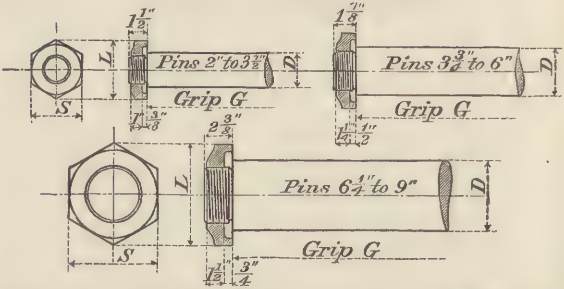
MAXIMUM BENDING MOMENTS ON PINS,

WITH EXTREME FIBRE STRAINS

VARYING FROM 15,000 TO 25,000 POUNDS PER SQUARE INCH.

Diameter of Pin in Inches.	*Area of Pin in Sq. Inches.*	*Moments in Inch-Pounds for Fibre Strains of*				*Diameter of Pin in Inches.*
		15,000 *lbs.* *per* *Sq Inch.*	20,000 *lbs.* *per* *Sq. Inch.*	22,000 *lbs.* *per* *Sq. Inch.*	25,000 *lbs.* *per* *Sq. Inch.*	
6	28.274	318100	424100	466500	530200	6
6 1/8	29.465	338400	451200	496300	564000	6 1/8
6 1/4	30.680	359500	479400	527300	599200	6 1/4
6 3/8	31.919	381500	508700	559600	635900	6 3/8
6 1/2	33.183	404400	539200	593100	674000	6 1/2
6 5/8	34.472	428200	570900	628000	713700	6 5/8
6 3/4	35.785	452900	603900	664200	754800	6 3/4
6 7/8	37.122	478500	638000	701800	797500	6 7/8
7	38.485	505100	673500	740800	841900	7
7 1/8	39.871	532700	710200	781200	887800	7 1/8
7 1/4	41.282	561200	748200	823000	935300	7 1/4
7 3/8	42.718	590700	787600	866300	984500	7 3/8
7 1/2	44.179	621300	828400	911200	1035400	7 1/2
7 5/8	45.664	652900	870500	957500	1088100	7 5/8
7 3/4	47.173	685500	914000	1005300	1142500	7 3/4
7 7/8	48.707	719200	958900	1054800	1198700	7 7/8
8	50.265	754000	1005300	1105800	1256600	8
8 1/8	51.849	789900	1053200	1158500	1316500	8 1/8
8 1/4	53.456	826900	1102500	1212800	1378200	8 1/4
8 3/8	55.088	865100	1153400	1268800	1441800	8 3/8
8 1/2	56.745	904400	1205800	1326400	1507300	8 1/2
8 5/8	58.426	944900	1259800	1385800	1574800	8 5/8
8 3/4	60.132	986500	1315400	1446900	1644200	8 3/4
8 7/8	61.862	1029400	1372500	1509800	1715700	8 7/8
9	63.617	1073500	1431400	1574500	1789200	9
9 1/8	65.397	1118900	1491900	1641100	1864800	9 1/8
9 1/4	67.201	1165500	1554000	1709400	1942500	9 1/4
9 3/8	69.029	1213400	1617900	1779600	2022300	9 3/8
9 1/2	70.882	1262600	1683400	1851800	2104300	9 1/2
9 5/8	72.760	1313100	1750800	1925900	2188500	9 5/8
9 3/4	74.662	1364900	1819900	2001900	2274900	9 3/4
9 7/8	76.590	1418100	1890800	2079900	2363500	9 7/8
10	78.54	1472600	1963500	2159900	2454400	10
10 1/4	82.52	1585900	2114500	2325900	2643100	10 1/4
10 1/2	86.59	1704700	2273000	2500200	2841200	10 1/2
10 3/4	90.76	1829400	2439300	2683200	3049100	10 3/4
11	95.03	1960100	2613400	2874800	3266800	11
11 1/4	99.40	2096800	2795700	3075400	3494800	11 1/4
11 1/2	103.87	2239700	2986300	3284800	3732800	11 1/2
12	113.10	2544700	3392900	3732200	4241200	12

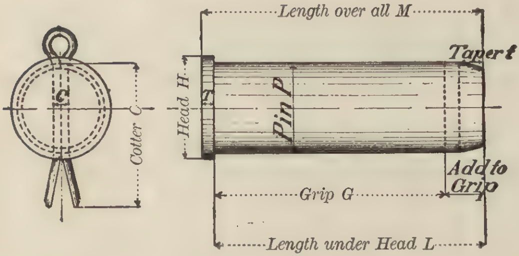
STANDARD PINS AND NUTS FROM 2″ TO 9″ DIAMETER.



PIN.						NUT.				Additional Amt. Added for Grip.	WASHER.		
Diameter of Pin.		Diameter of Pin Hole.	Play in Pin Hole.	Screw. Diameter.	Screw. Length.	Size of Rough Hole.	Short Diameter. S.	Long Diameter. L.	Weight of Nut.		Diameter.	Thickness.	Hole.
2	2.00	2.030	0.030	1 1/2	1 1/2	1 5/16	3 1/4	3 3/4	2 1/2	1/4	4 1/4	3/8	2 1/8
2 1/4	2.25	2.280	0.030	1 1/2	1 1/2	1 5/16	3 1/4	3 3/4	2 1/2	1/4	4 1/4	3/8	2 3/8
2 1/2	2.50	2.530	0.030	2	1 1/2	1 13/16	3 3/4	4 5/16	2 1/2	1/4	4 3/4	3/8	2 5/8
2 3/4	2.75	2.780	0.030	2	1 1/2	1 13/16	3 3/4	4 5/16	2 1/2	1/4	5	3/8	2 7/8
3	3.00	3.030	0.030	2 1/2	1 1/2	2 5/16	4 1/2	5 3/16	3	1/4	5 3/4	3/8	3 1/8
3 1/4	3.25	3.280	0.030	2 1/2	1 1/2	2 5/16	4 1/2	5 3/16	3	1/4	5 3/4	3/8	3 3/8
3 1/2	3.50	3.530	0.030	2 1/2	1 1/2	2 5/16	4 1/2	5 3/16	3	1/4	6 1/8	3/8	3 5/8
3 3/4	3.75	3.771	0.021	3	1 7/8	2 13/16	5	5 3/4	5 1/2	1/2	6 1/2	1/2	3 7/8
4	4.00	4.022	0.022	3	1 7/8	2 13/16	5	5 3/4	5 1/2	1/2	6 3/4	1/2	4 1/8
4 1/4	4.25	4.273	0.023	3 1/2	1 7/8	3 5/16	5 3/4	6 5/8	7	1/2	7 1/4	1/2	4 3/8
4 1/2	4.50	4.524	0.024	3 1/2	1 7/8	3 5/16	5 3/4	6 5/8	7	1/2	7 3/8	1/2	4 5/8
4 3/4	4.75	4.775	0.025	3 1/2	1 7/8	3 5/16	5 3/4	6 5/8	7	1/2	7 3/4	1/2	4 7/8
5	5.00	5.026	0.026	4	1 7/8	3 13/16	6 1/2	7 1/2	8 1/2	1/2	8	1/2	5 1/8
5 1/4	5.25	5.277	0.027	4	1 7/8	3 13/16	6 1/2	7 1/2	8 1/2	1/2	8 3/8	1/2	5 3/8
5 1/2	5.50	5.528	0.028	4 1/2	1 7/8	4 5/16	7	8 1/8	11	1/2	8 3/4	1/2	5 5/8
5 3/4	5.75	5.779	0.029	4 1/2	1 7/8	4 5/16	7	8 1/8	11	1/2	9 1/8	1/2	5 7/8
6	6.00	6.030	0.030	4 1/2	1 7/8	4 5/16	7	8 1/8	11	1/2	9 1/2	1/2	6 1/8
6 1/4	6.25	6.28	0.030	5	2 3/8	4 13/16	7 3/4	8 15/16	12	3/4	9 7/8	5/8	6 3/8
6 1/2	6.50	6.53	0.030	5	2 3/8	4 13/16	7 3/4	8 15/16	12	3/4	10 1/4	5/8	6 5/8
6 3/4	6.75	6.78	0.030	5 1/2	2 3/8	5 5/16	8 1/4	9 1/2	13 1/2	3/4	10 5/8	5/8	6 7/8
7	7.00	7.03	0.030	5 1/2	2 3/8	5 5/16	8 1/4	9 1/2	13 1/2	3/4	10 7/8	5/8	7 1/8
7 1/4	7.25	7.28	0.030	6	2 3/8	5 13/16	9	10 3/8	17	3/4	11 1/8	5/8	7 3/8
7 1/2	7.50	7.53	0.030	6	2 3/8	5 13/16	9	10 3/8	17	3/4	11 1/2	5/8	7 5/8
7 3/4	7.75	7.78	0.030	6 1/2	2 3/8	6 5/16	9 1/2	11		3/4	11 7/8	5/8	7 7/8
8	8.00	8.03	0.030	6 1/2	2 3/8	6 5/16	9 1/2	11		3/4	12 1/4	5/8	8 1/8
8 1/4	8.25	8.28	0.030	7	2 3/8	6 13/16	10 1/4	11 13/16		3/4	12 5/8	5/8	8 3/8
8 1/2	8.50	8.53	0.030	7	2 3/8	6 13/16	10 1/4	11 13/16		3/4	13 1/4	5/8	8 5/8
8 3/4	8.75	8.78	0.030	7 1/2	2 3/8	7 5/16	11	12 11/16		3/4	13 5/8	5/8	8 7/8
9	9.00	9.03	0.030	7 1/2	2 3/8	7 5/16	11	12 11/16		3/4	14	5/8	9 1/8

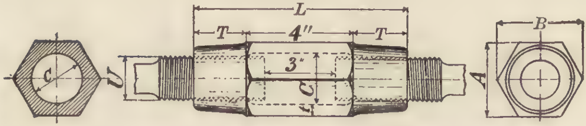
NOTE.—To obtain grip *G* of pin, add $\frac{1}{16}$ extra for each bar packed together with the proper additional amount given above in the table.

STANDARD COTTER PINS FROM $1''$ TO $3\frac{3}{4}''$ DIAMETER.



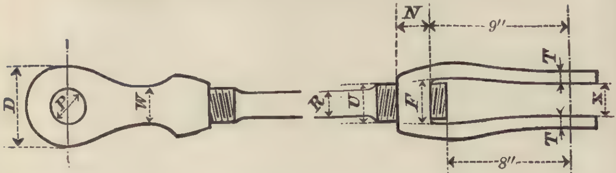
Diameter of Pin.		*Diameter of Pin Hole.*	*Play in Pin Hole.*	*Diameter of Head H.*	*Thickness of Head T.*	*Taper at End t.*	*Length L under Head equal to.*	*Length M over all equal to.*	*Size of Cotter C.*	*Diameter of Pin P.*
1	1.00	1.03	0.03	$1\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{16} \times \frac{1}{16}$	G + $\frac{5}{8}$	G + $\frac{7}{8}$	$\frac{1}{4} \times 1\frac{3}{4}$	1
$1\frac{1}{4}$	1.25	1.28	0.03	$1\frac{1}{2}$	$\frac{1}{4}$	$\frac{5}{16} \times \frac{1}{16}$	G + $\frac{5}{8}$	G + $\frac{7}{8}$	$\frac{1}{4} \times 2$	$1\frac{1}{4}$
$1\frac{1}{2}$	1.50	1.53	0.03	$1\frac{3}{4}$	$\frac{1}{4}$	$\frac{7}{16} \times \frac{3}{32}$	G + $\frac{3}{4}$	G + 1	$\frac{5}{16} \times 2\frac{1}{2}$	$1\frac{1}{2}$
$1\frac{3}{4}$	1.75	1.78	0.03	2	$\frac{1}{4}$	$\frac{7}{16} \times \frac{3}{32}$	G + $\frac{3}{4}$	G + 1	$\frac{5}{16} \times 2\frac{3}{4}$	$1\frac{3}{4}$
2	2.00	2.03	0.03	$2\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2} \times \frac{1}{8}$	G + $\frac{7}{8}$	G + $1\frac{1}{4}$	$\frac{3}{8} \times 3$	2
$2\frac{1}{4}$	2.25	2.28	0.03	$2\frac{5}{8}$	$\frac{3}{8}$	$\frac{1}{2} \times \frac{1}{8}$	G + $\frac{7}{8}$	G + $1\frac{1}{4}$	$\frac{3}{8} \times 3\frac{1}{4}$	$2\frac{1}{4}$
$2\frac{1}{2}$	2.50	2.53	0.03	$2\frac{7}{8}$	$\frac{3}{8}$	$\frac{5}{8} \times \frac{5}{32}$	G + $1\frac{1}{8}$	G + $1\frac{1}{2}$	$\frac{7}{16} \times 3\frac{3}{4}$	$2\frac{1}{2}$
$2\frac{3}{4}$	2.75	2.78	0.03	$3\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{8} \times \frac{5}{32}$	G + $1\frac{1}{8}$	G + $1\frac{1}{2}$	$\frac{7}{16} \times 4$	$2\frac{3}{4}$
3	3.00	3.03	0.03	$3\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4} \times \frac{3}{16}$	G + $1\frac{3}{8}$	G + $1\frac{7}{8}$	$\frac{1}{2} \times 5$	3
$3\frac{1}{4}$	3.25	3.28	0.03	$3\frac{3}{4}$	$\frac{1}{2}$	$\frac{3}{4} \times \frac{3}{16}$	G + $1\frac{3}{8}$	G + $1\frac{7}{8}$	$\frac{1}{2} \times 5$	$3\frac{1}{4}$
$3\frac{1}{2}$	3.50	3.53	0.03	4	$\frac{1}{2}$	$\frac{7}{8} \times \frac{7}{32}$	G + $1\frac{5}{8}$	G + $2\frac{1}{8}$	$\frac{5}{8} \times 6$	$3\frac{1}{2}$
$3\frac{3}{4}$	3.75	3.78	0.03	$4\frac{1}{4}$	$\frac{1}{2}$	$\frac{7}{8} \times \frac{7}{32}$	G + $1\frac{5}{8}$	G + $2\frac{1}{8}$	$\frac{5}{8} \times 6$	$3\frac{3}{4}$

PENCOYD STEEL SLEEVE NUTS.

U. S. Standard Thread.

Round Bars. Diam.	*Round Bars.* Area.	*Square Bars.* Side.	*Square Bars.* Area.	*Size of Upset.* U.	*Length of Thread.* T.	*Length of Nut.* L.	*Short Diam. Nut.* A.	*Long Diam. Nut.* B.	*Inside Diam. Nut.* C.	*Thickness.* t.	*Weight of One Sleeve Nut.* Lbs.
5/8	0.307			7/8 x 4	1 1/2	7	1 5/8	1 7/8	1 1/8	1/4	
3/4	0.442			1 x 4	1 1/2	7	1 5/8	1 7/8	1 1/8	1/4	
		3/4	0.563	1 1/8 x 4	1 3/4	7 1/2	2	2 5/16	1 3/8	5/16	3 1/2
7/8	0.601	7/8	0.766	1 1/4 x 4	1 3/4	7 1/2	2	2 5/16	1 3/8	5/16	4
1	0.785			1 3/8 x 4	2	8	2 3/8	2 3/4	1 5/8	3/8	4 1/2
1 1/8	0.994	1	1.000	1 1/2 x 4	2	8	2 3/8	2 3/4	1 5/8	3/8	6 1/2
1 1/4	1.227	1 1/8	1.266	1 5/8 x 4 1/2	2 1/4	8 1/2	2 3/4	3 3/16	1 7/8	7/16	8
1 3/8	1.485			1 3/4 x 4 1/2	2 1/4	8 1/2	2 3/4	3 3/16	1 7/8	7/16	8 1/2
		1 1/4	1.563	1 7/8 x 4 1/2	2 1/2	9	3 1/8	3 5/8	2 1/8	1/2	10
1 1/2	1.767	1 3/8	1.891	2 x 5	2 1/2	9	3 1/8	3 5/8	2 1/8	1/2	11
1 5/8	2.074			2 1/8 x 5	2 3/4	9 1/2	3 1/2	4 1/16	2 3/8	9/16	14
1 3/4	2.405	1 1/2	2.250	2 1/4 x 5	2 3/4	9 1/2	3 1/2	4 1/16	2 3/8	9/16	15
1 7/8	2.761	1 5/8	2.641	2 3/8 x 5 1/2	3	10	3 7/8	4 1/2	2 5/8	5/8	18
2	3.142	1 3/4	3.063	2 1/2 x 5 1/2	3	10	3 7/8	4 1/2	2 5/8	5/8	19
2 1/8	3.547			2 5/8 x 5 1/2	3 1/4	10 1/2	4 1/4	4 15/16	2 7/8	11/16	22
		1 7/8	3.516	2 3/4 x 6	3 1/4	10 1/2	4 1/4	4 15/16	2 7/8	11/16	23
2 1/4	3.976	2	4.000	2 7/8 x 6	3 1/2	11	4 5/8	5 3/8	3 1/8	3/4	27
2 3/8	4.430	2 1/8	4.516	3 x 6	3 1/2	11	4 5/8	5 3/8	3 1/8	3/4	28
2 1/2	4.909			3 1/8 x 6 1/2	3 3/4	11 1/2	5	5 13/16	3 3/8	13/16	34
2 5/8	5.412	2 1/4	5.063	3 1/4 x 6 1/2	3 3/4	11 1/2	5	5 13/16	3 3/8	13/16	35
2 3/4	5.940			3 3/8 x 7	4	12	5 3/8	6 1/8	3 5/8	7/8	39
		2 3/8	5.641	3 1/2 x 7	4	12	5 3/8	6 1/8	3 5/8	7/8	40
2 7/8	6.492	2 1/2	6.250	3 5/8 x 8	4 1/4	12 1/2	5 3/4	6 11/16	3 7/8	15/16	45
3	7.069			3 3/4 x 8	4 1/4	12 1/2	5 3/4	6 11/16	3 7/8	15/16	47
3 1/8	7.670	2 5/8	6.891	3 7/8 x 8	4 1/2	13	6 1/8	7 1/8	4 1/8	1	52
3 1/4	8.296	2 3/4	7.563	4 x 8	4 1/2	13	6 1/8	7 1/8	4 1/8	1	55
3 3/8	8.946	2 7/8	8.266	4 1/4 x 9	4 3/4	13 1/2	6 1/2	7 9/16	4 3/8	1 1/16	65
3 5/8	10.320	3	9.000	4 1/2 x 9	5	14	6 7/8	8	4 3/4	1 1/8	75

PENCOYD STEEL CLEVISES.

PROPORTIONED ACCORDING TO PENCOYD SPECIFICATIONS.

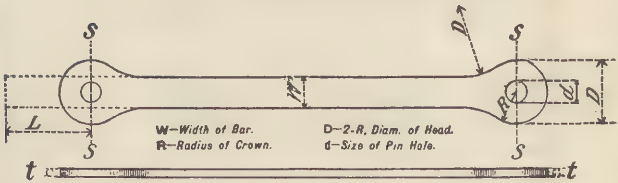


Distance *X* can be made to suit connections.—All dimensions in inches.

Size of Clevis.	*Square Rod.* R.	*Max. Pin.* P.	*Upset.* U.	*Diameter of Clevis.* D.	*Fork.* F.	*Nut.* N.	*Width.* W.	*Thickness.* T.	*Weight in Pounds.*
3½	1	1¾	1½ x 4	3½	1¾	1¾	1¾	½	
3½	⅞	2	1¼ x 4	3½	1¾	1¾	1¾	½	9
3½	¾	2	1⅛ x 4	3½	1¾	1¾	1¾	½	
4½	1¼	2¼	1⅞ x 4½	4½	2	2	2	⅝	
4½	1⅛	2½	1⅝ x 4½	4½	2	2	2	⅝	12½
4½	1	2½	1½ x 4	4½	2	2	2	⅝	
4½	⅞	2½	1¼ x 4	4½	2	2	2	⅝	
5	1⅜	2¼	2 x 5	5	2¼	2¼	2¼	⅝	
5	1¼	2¾	1⅞ x 4½	5	2¼	2¼	2¼	⅝	14
5	1⅛	2¾	1⅝ x 4½	5	2¼	2¼	2¼	⅝	
5	1	3	1½ x 4	5	2¼	2¼	2¼	⅝	
5½	1⅝	2½	2⅜ x 5½	5½	2½	2½	2½	¾	
5½	1½	2¾	2¼ x 5	5½	2½	2½	2½	¾	19
5½	1⅜	3	2 x 5	5½	2½	2½	2½	¾	
5½	1¼	3¼	1⅞ x 4½	5½	2½	2½	2½	¾	
6	1¾	2½	2½ x 5½	6	2¾	2¾	2¾	¾	
6	1⅝	3	2⅜ x 5½	6	2¾	2¾	2¾	¾	25
6	1½	3¼	2¼ x 5	6	2¾	2¾	2¾	¾	
6	1⅜	3½	2 x 5	6	2¾	2¾	2¾	¾	
6½	1⅞	3	2¾ x 6	6½	3	3	3	⅞	
6½	1¾	3¼	2½ x 5½	6½	3	3	3	⅞	30
6½	1⅝	3½	2⅜ x 5½	6½	3	3	3	⅞	
6½	1½	3¾	2¼ x 5	6½	3	3	3	⅞	
7	2	3	2⅞ x 6	7	3¼	3¼	3¼	⅞	
7	1⅞	3½	2¾ x 6	7	3¼	3¼	3¼	⅞	39
7	1¾	3¾	2½ x 5½	7	3¼	3¼	3¼	⅞	
7	1⅝	4	2⅜ x 5½	7	3¼	3¼	3¼	⅞	
7½	2¼	3	3¼ x 6½	7½	3½	3½	3½	1	
7½	2⅛	3½	3 x 6	7½	3½	3½	3½	1	49½
7½	2	4	2⅞ x 6	7½	3½	3½	3½	1	
7½	1⅞	4¼	2¾ x 6	7½	3½	3½	3½	1	

The size of pin given for each combination of bar and clevis is the maximum size allowed, and cannot be increased, but may be decreased.

PENCOYD STEEL EYE BARS.

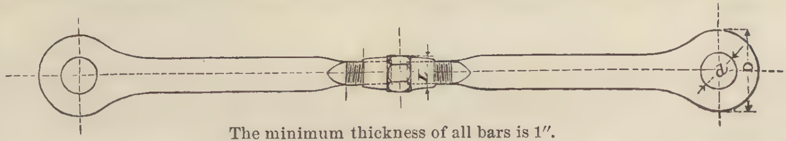


W *Width of Bar.*	*t* *Minimum Thickness of Bar.*	*D* *Diameter of Head.*	*d* *Diameter of Largest Pin.*	*L* *Additional Length of Bar Beyond Centre of Eye Required to Form One Head.*
3″	3/4″	7″	3″	1′ 3″
3″	3/4″	8″	3 7/8″	1′ 5 1/2″
4″	3/4″	9 1/2″	4 1/8″	1′ 7 1/2″
4″	3/4″	10 1/2″	5 1/16″	1′ 10″
5″	3/4″	11 1/2″	4 13/16″	1′ 9″
5″	1″	12 1/2″	5 11/16″	2′ 0 3/4″
6″	3/4″	13 1/2″	5 1/2″	1′ 11″
6″	1″	14 1/2″	6 5/16″	2′ 2 1/4″
7″	7/8″	16″	6 11/16″	2′ 2 3/4″
7″	15/16″	17″	7 1/2″	2′ 7 3/4″
8″	1″	17″	6″	2′ 2 3/4″
8″	1 1/16″	18″	7″	2′ 6″
8″	1 1/8″	18 1/2″	7 1/2″	2′ 9 3/4″
9″				
9″				
9″				
10″				
10″				
10″				
12″				
12″				
12″				

NOTE.—Pencoyd eye bars are hydraulic forged, and are guaranteed to develop the full strength of the bar, under conditions given in the above table, when tested to destruction. The maximum sizes of pins given in the above table allow an excess in sectional area of head on line "ss" over that of the body of the bar of 33 per cent. for diameters of pins, not larger than the width of the bar, and 36 per cent. for pins of larger diameter than the width of the bar; the thickness of eye being the same as the thickness of the body of the bar, or not exceeding the same by more than 1/16 of an inch.

The steel manufactured by us for the use of eye bars is open hearth steel, and will be furnished of such quality as to satisfy the demands of engineers.

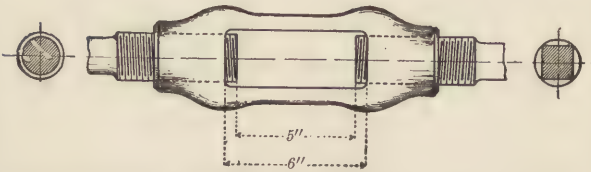
PENCOYD STEEL EYE BARS AND STEEL SLEEVE NUTS.



The minimum thickness of all bars is 1″.

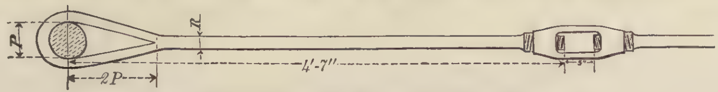
EYE BAR.								UPSET.						SLEEVE NUT.			
Width of Bar.	Thickness of Bar.	Min. Diam. of Head, with Max. Pin allowed.		Add for 1 Minimum Head.	Max. Diam. of Head, with Max. Pin allowed.		Add for 1 Maximum Head.	Diameter and Length of Screw.	Diameter of Root of Thread.	Area of Root of Thread.	Number of Threads per Inch.	Add for 1 Upset.	Length.	S. Hexagon.	L. Hexagon.	Weight of Sleeve Nut.
		Head D	Pin d		Head D	Pin d			Ins.	Sq. Ins.				Short Diam.	Long Diam.	lbs.
3″	1″ to 1 1/16″	7″	3″	1′ 3″	8″	3 7/8″	1′ 5 1/2″	2 1/2″ x 5 1/2″	2.175	3.719	4″	1′ 4 1/2″	10″	3 7/8″	4 1/2″	19
3″	1 1/8″ to 1 1/4″	7″	3″	1′ 3″	8″	3 7/8″	1′ 5 1/2″	2 3/4″ x 6″	2.425	4.620	4″	1′ 4 1/2″	10 1/2″	4 1/4″	4 15/16″	23
4″	1″ to 1 1/8″	9 1/2″	4 1/8″	1′ 7 1/2″	10 1/2″	5 1/16″	1′ 10″	3″ x 6″	2.629	5.428	3 1/2″	1′ 7 1/2″	11″	4 5/8″	5 3/8″	28
4″	1 3/16″ to 1 3/8″	9 1/2″	4 1/8″	1′ 7 1/2″	10 1/2″	5 1/16″	1′ 10″	3 1/4″ x 6 1/2″	2.879	6.510	3 1/2″	1′ 7 1/2″	11 1/2″	5″	5 13/16″	35
5″	1″ to 1 1/16″	11 1/2″	4 13/16″	1′ 9″	12 1/2″	5 11/16″	2′ 0 3/4″	3 1/4″ x 6 1/2″	2.879	6.510	3 1/2″	1′ 9″	11 1/2″	5″	5 13/16″	35
5″	1 1/8″ to 1 1/4″	11 1/2″	4 13/16″	1′ 9″	12 1/2″	5 11/16″	2′ 0 3/4″	3 1/2″ x 7″	3.100	7.548	3 1/4″	1′ 9″	12″	5 3/8″	6 1/8″	40
6″	1″ to 1 3/16″	13 1/2″	5 1/2″	1′ 11″	14 1/2″	6 5/16″	2′ 2 1/4″	3 3/4″ x 8″	3.317	8.641	3 1/4″	1′ 11″	12 1/2″	5 3/4″	6 11/16″	47
6″	1 1/4″ to 1 3/8″	13 1/2″	5 1/2″	1′ 11″	14 1/2″	6 5/16″	2′ 2 1/4″	4″ x 8″	3.567	9.963	3″	1′ 11″	13″	6 1/8″	7 1/8″	55
7″	1″ to 1 5/16″	16″	6 11/16″	2′ 2 3/4″	17″	7 1/2″	2′ 7 3/4″	4 1/4″ x 9″	3.798	11.33	2 7/8″	2′ 2 3/4″	13 1/2″	6 1/2″	7 9/16″	65
7″	1 3/8″ to 1 1/2″	16″	6 11/16″	2′ 2 3/4″	17″	7 1/2″	2′ 7 3/4″	4 1/2″ x 9″	4.028	12.75	2 3/4″	2′ 2 3/4″	14″	7″	8 1/16″	75

ALLOWANCE FOR UPSETS ON SQUARE AND ROUND STEEL BARS.



Round Bars.					Size of Upset.						Square Bars.				
Diameter.	Area Square Inches.	Weight per Lineal Foot.	Add for Upset.	Excess of Area @ Root of Thread.	Diameter.	Length.	Diameter at Root of Thread.	Area at Root of Thread.	No. of Threads per Inch.	Weight of One Turnbuckle.	Side of Square.	Area Square Inches.	Weight per Lineal Foot.	Add for Upset.	Excess of Area @ Root of Thread.
In.		Lbs.	In.	%	In.	In.	In.	Sq. In.		Lbs.	In.		Lbs.	In.	%
⅝	0.307	1.04	4½	36.8	⅞	4	0.731	0.420	9	2½					
¾	0.442	1.50	3⅞	24.4	1	4	0.837	0.550	8	3½					
					1⅛	4	0.940	0.694	7	4	¾	0.563	1.91	3½	20.6
⅞	0.601	2.04	5	48.3	1¼	4	1.065	0.891	7	5¼	⅞	0.766	2.60	4	16.3
1	0.785	2.67	4⅜	34.7	1⅜	4	1.160	1.057	6	6					
1⅛	0.994	3.38	3⅞	30.3	1½	4	1.284	1.295	6	7½	1	1.000	3.40	4	29.5
1¼	1.227	4.18	3⅞	23.5	1⅝	4½	1.389	1.515	5½	8½	1⅞	1.266	4.30	4½	19.7
1⅜	1.485	5.05	3½	17.4	1¾	4½	1.490	1.744	5	10					
					1⅞	4½	1.615	2.049	5	11½	1¼	1.563	5.31	4½	31.1
1½	1.767	6.01	4⅝	30.3	2	5	1.712	2.302	4½	13	1⅜	1.891	6.43	4⅛	21.7
1⅝	2.074	7.05	4¼	27.8	2⅛	5	1.837	2.651	4½	15					
1¾	2.405	8.18	4	25.7	2¼	5	1.962	3.023	4½	18	1½	2.250	7.65	4¾	34
1⅞	2.761	9.39	4⅛	23.9	2⅜	5½	2.087	3.410	4	20	1⅝	2.641	8.98	4⅝	29.6
2	3.142	10.68	3⅞	18.3	2½	5½	2.175	3.716	4	24	1¾	3.063	10.41	4¼	21.3
2⅛	3.547	12.06	3⅝	17.1	2⅝	5½	2.300	4.155	4	28					
					2¾	6	2.425	4.619	4	30	1⅞	3.516	11.95	5⅛	31.4
2¼	3.976	13.52	4⅝	28.5	2⅞	6	2.550	5.107	3½	34	2	4.000	13.60	4¾	27.7
2⅜	4.430	15.07	4⅜	22.6	3	6	2.629	5.430	3½	38	2⅛	4.516	15.35	4⅜	20.2
2½	4.909	16.69	4⅜	21.3	3⅛	6½	2.754	5.957	3½	50					
2⅝	5.412	18.40	4¼	20.3	3¼	6½	2.879	6.510	3½	50	2¼	5.063	17.22	5⅛	28.6
2¾	5.940	20.20	4¼	19.3	3⅜	7	3.004	7.088	3¼	65					
					3½	7	3.100	7.548	3¼	65	2⅜	5.641	19.18	6⅛	33.8
2⅞	6.492	22.07	5½	25.9	3⅝	8	3.225	8.170	3¼		2½	6.250	21.25	6¼	30.7
3	7.069	24.03	5¼	22.2	3¾	8	3.317	8.641	3¼						
3⅛	7.670	26.08	5⅛	21.3	3⅞	8	3.442	9.305	3		2⅝	6.891	23.43	6¾	35.0
3¼	8.296	28.20	4⅞	20.7	4	8	3.567	9.9935	3		2¾	7.563	25.71	6	25.1
3⅜	8.946	30.42	6	26.6	4¼	9	3.798	11.33	2⅞		2⅞	8.266	28.10	8	37.0
3⅝	10.32	35.09	4½	23.6	4½	9	4.028	12.75	2¾		3	9.000	30.60	7½	41.7

ALLOWANCE FOR EYE FOR SQUARE OR ROUND BARS.



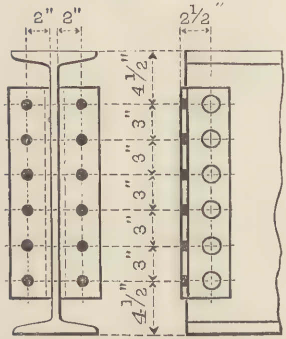
Length in inches beyond pin centre to form one eye.

Diameter of Pin in Inches.	Diameter or Side of Bars in Inches.																			Diameter of Pin in Inches.
	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞	3	
1	11½	12	12½																	1
1¼	12½	12⅞	13⅜	13⅞	14¼															1¼
1½	13⅜	13⅞	14¼	14¾	15¼	15⅝	16⅛													1½
1¾	14¼	14¾	15¼	15⅝	16⅛	16⅝	17	17½	18											1¾
2	15¼	15⅜	16⅛	16⅜	17	17½	18	18⅜	18⅞	19⅜	19¾									2
2¼	16⅛	16⅜	17	17½	18	18⅜	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝							2¼
2½	17	17½	18	18⅜	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	23	23½					2½
2¾	18	18⅜	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅜			2¾
3	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	3
3¼	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	3¼
3½	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	3½
3¾	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅝	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	3¾
4	22⅝	23	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	4
4¼	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	4¼
4½	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	4½
4¾	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	4¾
5	26¼	26¾	27¼	27⅝	28⅛	28⅜	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	34⅛	34⅝	5
5¼	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	34⅛	34⅝	35	35½	5¼
5½	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	34⅛	34⅝	35	35½	36	36½	5½
5¾	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	34⅛	34⅝	35	35½	36	36½	37	37⅜	5¾
6	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	34⅛	34⅝	35	35½	36	36½	37	37⅜	37⅞	38⅜	6

NOTE.—The maximum shipping length should not exceed 35 feet.

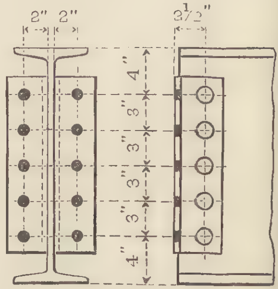
STANDARD FRAMING OF PENCOYD BEAMS AND CHANNELS.

24″



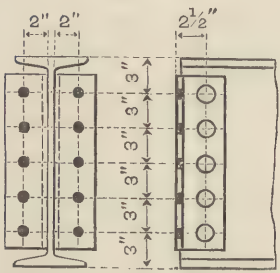
2 Angles 4″ x 3½″ x $\frac{7}{16}$″ x 18″.

20″



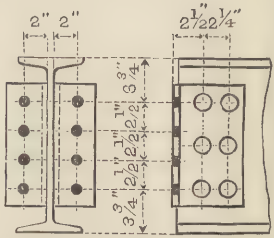
2 Angles 4″ x 3½″ x $\frac{7}{16}$″ x 15″.

18″



2 Angles 4″ x 3½″ x $\frac{7}{16}$″ x 15″.

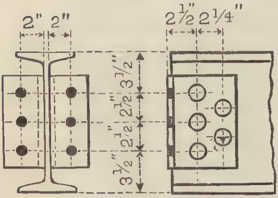
15″



2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 10½″.

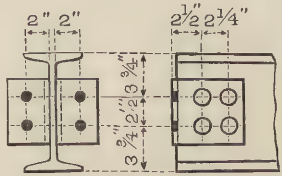
STANDARD FRAMING OF PENCOYD BEAMS AND CHANNELS.

12″



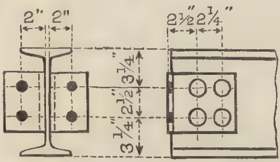
2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 8″.

10″



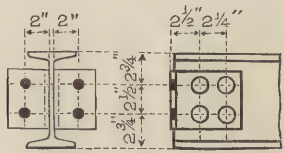
2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 5″.

9″



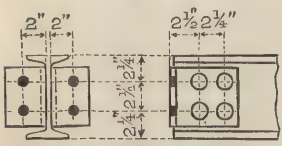
2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 5″.

8″



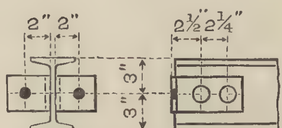
2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 5″.

7″



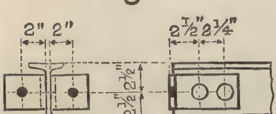
2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 5″.

6″



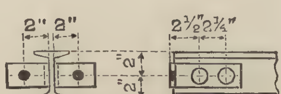
2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 3″.

5″



2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 3″.

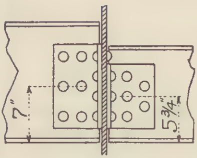
4″



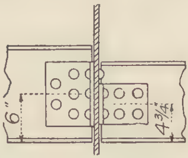
2 Angles 6″ x 3½″ x $\frac{7}{16}$″ x 2″.

CONNECTIONS FOR BEAMS OF DIFFERENT DEPTHS.

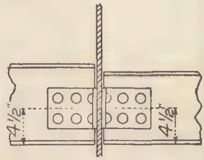
(Framing Opposite.)



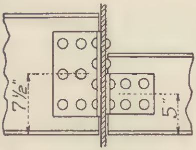
15″ I and 12″ I.



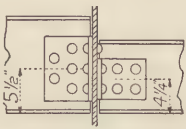
12″ I and 10″ I.



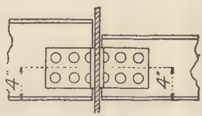
10″ I and 9″ I.



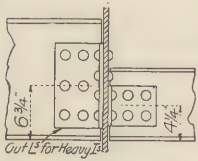
15″ I and 10″ I.



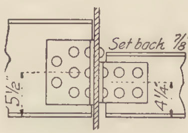
12″ I and 9″ I.



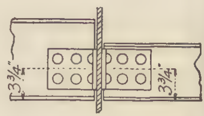
10″ I and 8″ I.
9″ I and 8″ I.



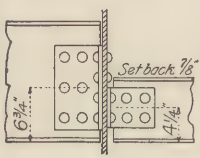
15″ I and 9″ I.



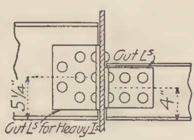
12″ I and 8″ I.



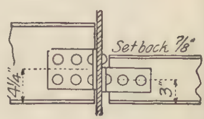
10″ I and 7″ I.
9″ I and 7″ I.
8″ I and 7″ I.



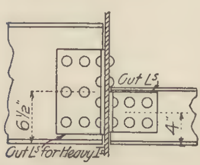
15″ I and 8″ I.



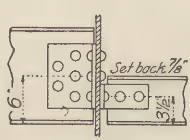
12″ I and 7″ I.



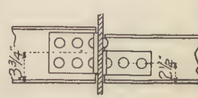
10″ I and 6″ I.
9″ I and 6″ I.
8″ I and 6″ I.



15″ I and 7″ I.

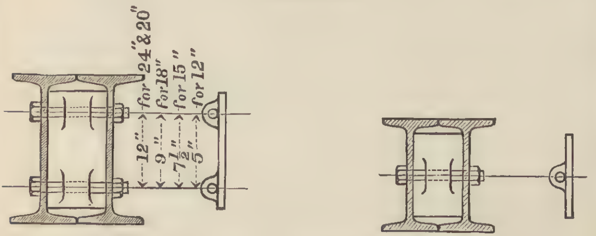


12″ I and 6″ I.



7″ I and 6″ I.

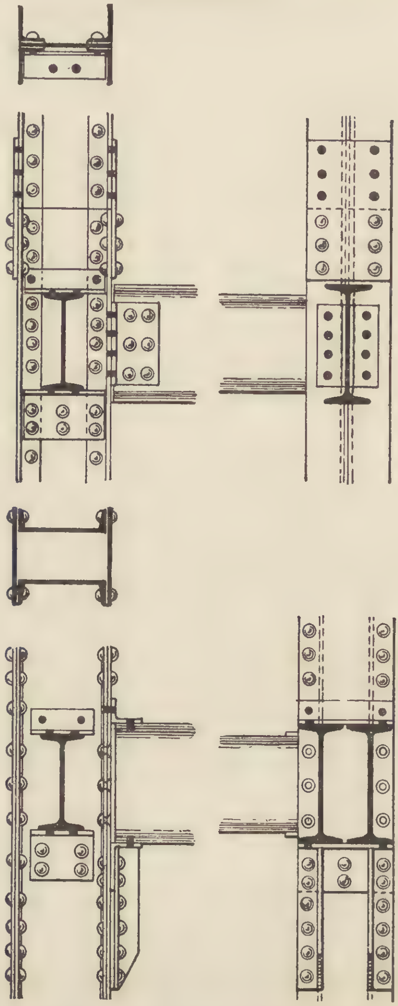
STANDARD SEPARATORS FOR PENCOYD I BEAMS.



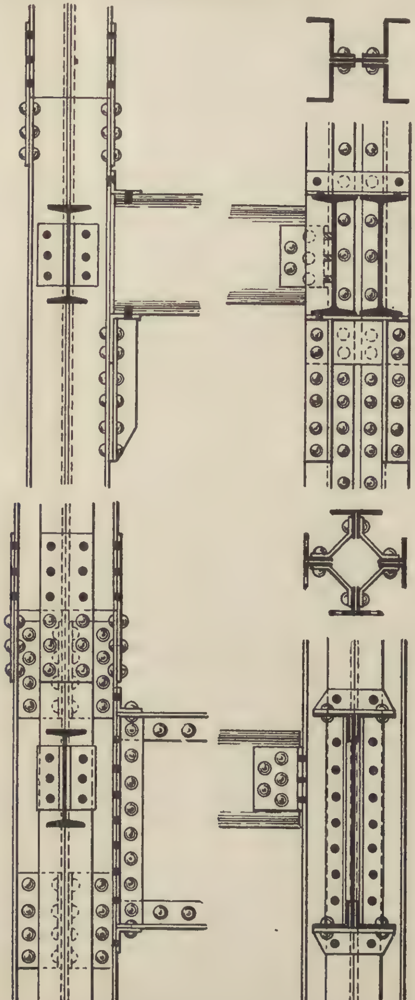
Size of Beam in Inches.	Weight of Separator in Pounds.	Weight of Each Additional Inch of Width in Pounds.	Bolts.		Weight of Each Complete Bolt in Pounds.	Weight of Each Additional Inch of Length in Pounds.
			Number.	Size in Inches.		
24	28.0	4.50	2	3/4	1.42	.124
20	23.0	3.20	2	3/4	1.35	.124
18	21.0	3.20	2	3/4	1.30	.124
15	14.75	1.90	2	3/4	1.20	.124
12	9.75	1.50	2	3/4	1.14	.124
10	6.50	1.20	1	3/4	1.08	.124
9	5.75	1.10	1	3/4	1.04	.124
8	4.50	1.00	1	3/4	1.01	.124
7	3.75	0.90	1	3/4	0.95	.124
6	2.25	0.65	1	3/4	0.93	.124
5	2.00	0.55	1	3/4	0.90	.124
4	1.75	0.45	1	3/4	0.80	.124

Separators for 18″, 20″ and 24″ Beams are made of $\frac{5}{8}$″ metal.
Separators for 3″ to 15″ Beams are made of $\frac{1}{2}$″ metal.

CONNECTIONS OF FLOOR BEAMS TO COLUMNS.



CONNECTIONS OF FLOOR BEAMS TO COLUMNS.



STANDARD ANGLE CONNECTIONS.

The connections illustrated on preceding pages are proportioned, for a load uniformly distributed over a minimum length of span as given below:

Size of Beams.	*Section Number.*	*Minimum Safe Span in Feet.*	*Size of Beams.*	*Section Number.*	*Minimum Safe Span in Feet.*	*Size of Beams.*	*Section Number.*	*Minimum Safe Span in Feet.*
24	240B	19.0						
20	203B	17.5	12	124B	12.0	8	80B	5.0
20	200B	16.0	12	122B	9.0	7	70B	4 0
18	183B	16.0	12	120B	7.5	6	67B	6.0
18	180B	14.0	10	102B	8.5	5	50B	4.5
15	156B	14.5	10	100B	7.0	4	40B	3.0
15	154B	12.0	9	90B	5.5	3	30B	2.0
15	152B	10.0						

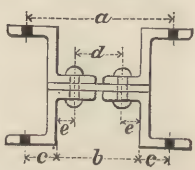
All holes $\frac{13}{16}''$. All rivets $\frac{3}{4}''$.

When beams frame opposite each other into another beam or girder with web thickness less than $\frac{9}{16}''$, the above given minimum lengths of spans ought to be increased in the proportion of the web thickness to $\frac{9}{16}''$.

These connections are based on shearing strains of 10,000 pounds per square inch, and bearing strains of 20,000 pounds per square inch, when the length of attached beams correspond to the foregoing table, and extreme fibre stress of 16,000 pounds per square inch at beam flanges.

STANDARD SPACING of RIVETS THROUGH FLANGES OF Z BAR COLUMNS.

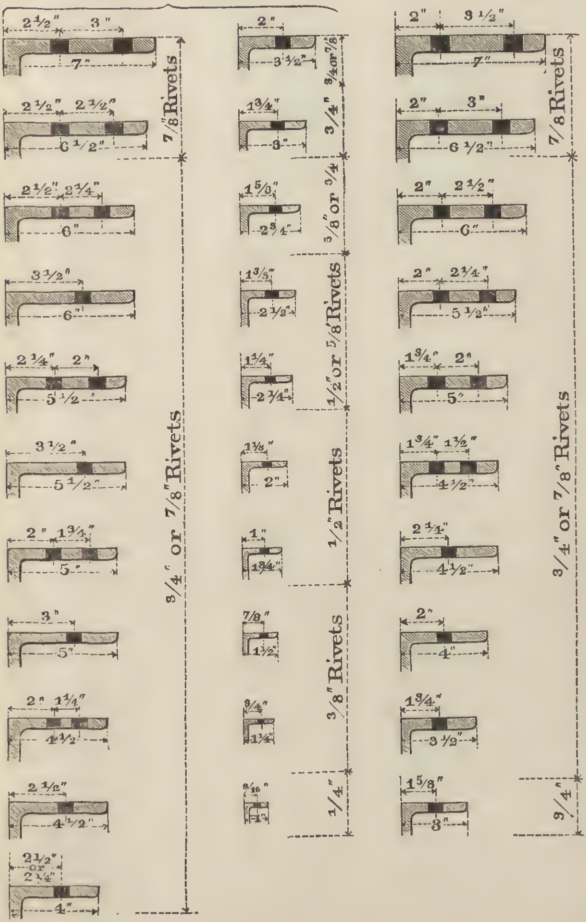
Size of Z Bar.	*a.*	*b.*	*c.*	*d.*	*e.*
6 inch.	11¼	7¼	2	4¼	1½
5 "	10	6½	1¾	4	1¼
4 "	8¾	5½	1⅝	3	1¼
3 "	7¾	4¾	1½	2½	1⅛



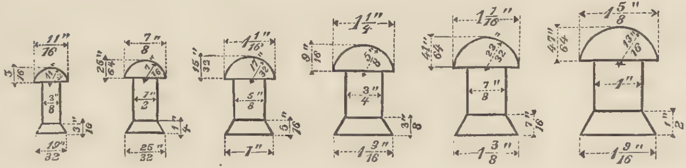
ALL RIVETS ¾ INCH.

RIVET SPACING IN PENCOYD ANGLES.

Spacing for Flanges. Spacing for Braces, Etc.



PENCOYD RIVET PROPORTIONS.



FINISHED·HEADS.

Diam. Head = 1½ Diam. of Shank + ⅛". Depth of Head = $\frac{45}{100}$ Diam. of Head.

COUNTERSUNK.

Depth of Head = ½ Diam. of Shank. Bevel of Head = 60 Degrees.

PENCOYD RIVET SIGNS.

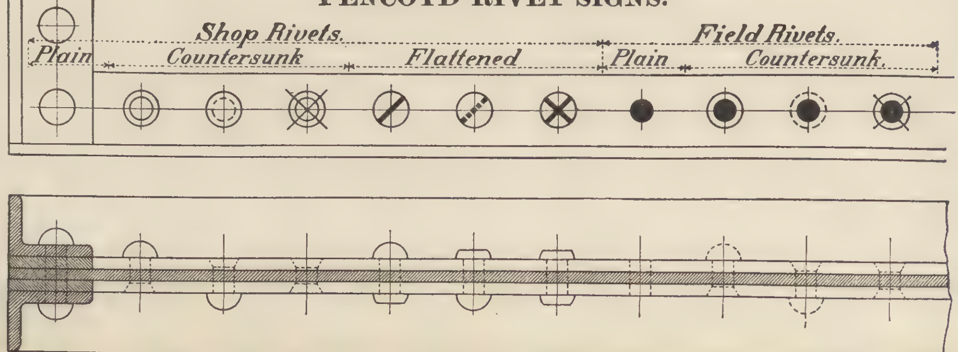
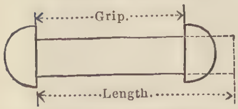
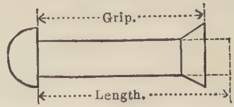


TABLE SHOWING LENGTH OF RIVET-SHANK REQUIRED TO FORM HEAD.

PLAIN RIVETS. **COUNTERSUNK RIVETS.**





Grip in Inches.	Plain: *Diameter in Inches.*					Grip in Inches.	Countersunk: *Diameter in Inches.*					Grip in Inches.
	½	5/8	3/4	7/8	1		½	5/8	3/4	7/8	1	
	Length in Inches.						*Length in Inches.*					
½	1 5/8	1 7/8	2	2 1/8	2 1/4	½	1 1/4	1 3/8	1 3/8	1 1/2	1 1/2	½
5/8	1 3/4	2	2 1/8	2 1/4	2 3/8	5/8	1 3/8	1 1/2	1 1/2	1 5/8	1 5/8	5/8
3/4	1 7/8	2 1/8	2 1/4	2 3/8	2 1/2	3/4	1 1/2	1 5/8	1 5/8	1 3/4	1 3/4	3/4
7/8	2	2 1/4	2 3/8	2 1/2	2 5/8	7/8	1 5/8	1 3/4	1 3/4	1 7/8	1 7/8	7/8
1	2 1/8	2 3/8	2 1/2	2 5/8	2 3/4	1	1 3/4	1 7/8	1 7/8	2	2	1
1 1/8	2 1/4	2 1/2	2 5/8	2 3/4	2 7/8	1 1/8	1 7/8	2	2	2 1/8	2 1/8	1 1/8
1 1/4	2 3/8	2 5/8	2 3/4	2 7/8	3	1 1/4	2	2 1/8	2 1/8	2 1/4	2 1/4	1 1/4
1 3/8	2 1/2	2 3/4	2 7/8	3	3 1/8	1 3/8	2 1/8	2 1/4	2 1/4	2 3/8	2 3/8	1 3/8
1 1/2	2 3/4	3	3 1/8	3 1/4	3 3/8	1 1/2	2 1/4	2 3/8	2 1/2	2 1/2	2 5/8	1 1/2
1 5/8	2 7/8	3 1/8	3 1/4	3 3/8	3 1/2	1 5/8	2 3/8	2 1/2	2 5/8	2 5/8	2 3/4	1 5/8
1 3/4	3	3 1/4	3 3/8	3 1/2	3 5/8	1 3/4	2 1/2	2 5/8	2 3/4	2 3/4	2 7/8	1 3/4
1 7/8	3 1/8	3 3/8	3 1/2	3 5/8	3 3/4	1 7/8	2 5/8	2 3/4	2 7/8	2 7/8	3	1 7/8
2	3 1/4	3 1/2	3 5/8	3 3/4	3 7/8	2	2 3/4	2 7/8	3	3	3 1/8	2
2 1/8	3 3/8	3 5/8	3 3/4	3 7/8	4	2 1/8	2 7/8	3	3 1/8	3 1/8	3 1/4	2 1/8
2 1/4	3 1/2	3 3/4	3 7/8	4	4 1/8	2 1/4	3	3 1/8	3 1/4	3 1/4	3 3/8	2 1/4
2 3/8	3 5/8	3 7/8	4	4 1/8	4 1/4	2 3/8	3 1/8	3 1/4	3 3/8	3 3/8	3 1/2	2 3/8
2 1/2	3 3/4	4	4 1/8	4 1/4	4 3/8	2 1/2	3 1/4	3 3/8	3 1/2	3 1/2	3 5/8	2 1/2
2 5/8	3 7/8	4 1/8	4 1/4	4 3/8	4 1/2	2 5/8	3 3/8	3 1/2	3 5/8	3 5/8	3 3/4	2 5/8
2 3/4	4	4 1/4	4 3/8	4 1/2	4 5/8	2 3/4	3 1/2	3 5/8	3 3/4	3 3/4	3 7/8	2 3/4
2 7/8	4 1/8	4 3/8	4 1/2	4 5/8	4 3/4	2 7/8	3 5/8	3 3/4	3 7/8	3 7/8	4	2 7/8
3	4 3/8	4 5/8	4 3/4	4 7/8	5	3	3 7/8	3 7/8	4	4 1/8	4 1/4	3
3 1/8	4 1/2	4 3/4	4 7/8	5	5 1/8	3 1/8	4	4	4 1/8	4 1/4	4 3/8	3 1/8
3 1/4	4 5/8	4 7/8	5	5 1/8	5 1/4	3 1/4	4 1/8	4 1/4	4 1/4	4 3/8	4 1/2	3 1/4
3 3/8	4 3/4	5	5 1/8	5 1/4	5 3/8	3 3/8	4 1/4	4 3/8	4 3/8	4 1/2	4 5/8	3 3/8
3 1/2	4 7/8	5 1/8	5 1/4	5 3/8	5 1/2	3 1/2	4 3/8	4 1/2	4 1/2	4 5/8	4 3/4	3 1/2
3 5/8	5	5 1/4	5 3/8	5 1/2	5 5/8	3 5/8	4 1/2	4 5/8	4 5/8	4 3/4	4 7/8	3 5/8
3 3/4	5 1/8	5 3/8	5 1/2	5 5/8	5 3/4	3 3/4	4 5/8	4 3/4	4 3/4	4 7/8	5	3 3/4
3 7/8	5 1/4	5 1/2	5 5/8	5 3/4	5 7/8	3 7/8	4 3/4	4 7/8	4 7/8	5	5 1/8	3 7/8
4	5 3/8	5 5/8	5 3/4	5 7/8	6	4	4 7/8	5	5 1/8	5 1/8	5 1/4	4
4 1/8	5 1/2	5 3/4	5 7/8	6	6 1/8	4 1/8	5	5 1/8	5 1/4	5 1/4	5 3/8	4 1/8
4 1/4	5 5/8	5 7/8	6	6 1/8	6 1/4	4 1/4	5 1/8	5 1/4	5 3/8	5 3/8	5 1/2	4 1/4
4 3/8	5 3/4	6	6 1/8	6 1/4	6 3/8	4 3/8	5 1/4	5 3/8	5 1/2	5 1/2	5 5/8	4 3/8
4 1/2	6	6 1/4	6 3/8	6 1/2	6 5/8	4 1/2				5 5/8	5 3/4	4 1/2
4 5/8	6 1/8	6 3/8	6 1/2	6 5/8	6 3/4	4 5/8				5 3/4	5 7/8	4 5/8
4 3/4	6 1/4	6 1/2	6 5/8	6 3/4	6 7/8	4 3/4				5 7/8	6	4 3/4
4 7/8	6 3/8	6 5/8	6 3/4	6 7/8	7	4 7/8				6	6 1/8	4 7/8
5	6 1/2	6 3/4	6 7/8	7	7 1/8	5				6 1/8	6 1/4	5
5 1/8	6 5/8	6 7/8	7	7 1/8	7 1/4	5 1/8				6 1/4	6 3/8	5 1/8
5 1/4	6 3/4	7	7 1/8	7 1/4	7 3/8	5 1/4				6 3/8	6 1/2	5 1/4

For weight of rivets, see page 268.

SHEARING AND BEARING VALUE OF RIVETS IN POUNDS.

GENERAL SPECIFICATIONS.

All dimensions in inches.

Diameter of Rivet. Inches. Fraction.	Decimal.	Area in Square Inches.	Single Shear at 6,000 Lbs.	Bearing Value for Different Thicknesses of Plate in Inches, at 12,000 Pounds per Square Inch. $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
3/8	.375	.1104	660	1130	1410	1690										
1/2	.500	.1963	1180	1500	1880	2250	2630	3000								
5/8	.625	.3068	1840	1880	2340	2810	3280	3750	4220	4690						
3/4	.750	.4418	2650	2250	2810	3380	3940	4500	5160	5630	6190	6750				
7/8	.875	.6013	3610	2630	3280	3940	4590	5250	5910	6560	7220	7880	8530	9190	9840	
1	1.000	.7854	4710	3000	3750	4500	5250	6000	6750	7500	8250	9000	9750	10500	11250	12000

Diameter of Rivet. Inches. Fraction.	Decimal.	Area in Square Inches.	Single Shear at 7,500 Pounds.	Bearing Value for Different Thicknesses of Plate in Inches, at 15,000 Pounds per Square Inch. $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
3/8	.375	.1104	830	1410	1760	2110										
1/2	.500	.1963	1470	1880	2340	2810	3280	3750								
5/8	.625	.3068	2300	2340	2930	3520	4100	4690	5280	5860						
3/4	.750	.4418	3310	2810	3520	4220	4920	5630	6330	7030	7720	8440				
7/8	.875	.6013	4510	3280	4100	4920	5740	6560	7380	8200	9030	9850	10670	11480	12300	
1	1.000	.7854	5890	3750	4690	5620	6560	7500	8440	9380	10310	11250	12190	13130	14060	15000

In above tables all bearing values above or to right of upper zigzag lines are greater than double shear.
Values between upper and lower zigzag lines are less than double and greater than single shear.
Values below and to left of lower zigzag lines are less than single shear.

SHEARING AND BEARING VALUE OF RIVETS IN POUNDS.

PENCOYD SPECIFICATIONS.

Diameter of Rivet. Inches. Fraction.	Diameter of Rivet. Inches. Decimal.	Area in Square Inches.	Single Shear at 11,000 Lbs.	Bearing Value for Different Thicknesses of Plate in Inches, at 22,000 Pounds per Square Inch.												
				1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
3/8	.375	.1104	1210	2060	2580	3090										
1/2	.500	.1963	2160	2750	3440	4130	4820	5500								
5/8	.625	.3068	3370	3440	4300	5160	6020	6880	7740	8600						
3/4	.750	.4418	4860	4130	5160	6190	7220	8250	9280	10320	11340	12380				
7/8	.875	.6013	6610	4810	6020	7220	8430	9630	10840	12040	13240	14440	15640	16840	18050	
1	1.000	.7854	8640	5500	6880	8250	9630	11000	12380	13750	15130	16500	17880	19250	20630	22000

All bearing values above or to right of upper zigzag lines are greater than double shear.
Values below or to left of lower zigzag lines are less than single shear.

U. S. STANDARD SCREW THREADS.

Diam.	*Threads per Inch.*	*Diam. of Root of Thread.*	*Width of Flat.*	*Area of Bolt Body in Sq. Inches.*	*Area at Root of Thread in Sq. Inches.*	*Short Diam., Rough.*	*Short Diam., Finish.*	*Long Diam., Rough.*	*Long Diam., Rough.*	*Thickness, Rough.*	*Thickness, Finish.*
Ins.		*Ins.*	*Ins.*			*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
$\frac{1}{4}$	20	.185	.0062	.049	.027	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{37}{64}$	$\frac{7}{10}$	$\frac{1}{4}$	$\frac{3}{16}$
$\frac{5}{16}$	18	.240	.0074	.077	.045	$\frac{19}{32}$	$\frac{17}{32}$	$\frac{11}{16}$	$\frac{10}{12}$	$\frac{5}{16}$	$\frac{1}{4}$
$\frac{3}{8}$	16	.294	.0078	.110	.068	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{51}{64}$	$\frac{63}{64}$	$\frac{3}{8}$	$\frac{5}{16}$
$\frac{7}{16}$	14	.344	.0089	.150	.093	$\frac{25}{32}$	$\frac{23}{32}$	$\frac{9}{10}$	$1\frac{7}{64}$	$\frac{7}{16}$	$\frac{3}{8}$
$\frac{1}{2}$	13	.400	.0096	.196	.126	$\frac{7}{8}$	$\frac{13}{16}$	1	$1\frac{15}{64}$	$\frac{1}{2}$	$\frac{7}{16}$
$\frac{9}{16}$	12	.454	.0104	.249	.162	$\frac{31}{32}$	$\frac{29}{32}$	$1\frac{1}{8}$	$1\frac{23}{64}$	$\frac{9}{16}$	$\frac{1}{2}$
$\frac{5}{8}$	11	.507	.0113	.307	.202	$1\frac{1}{16}$	1	$1\frac{7}{32}$	$1\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$
$\frac{3}{4}$	10	.620	.0125	.442	.302	$1\frac{1}{4}$	$1\frac{3}{16}$	$1\frac{7}{16}$	$1\frac{49}{64}$	$\frac{3}{4}$	$\frac{11}{16}$
$\frac{7}{8}$	9	.731	.0138	.601	.420	$1\frac{7}{16}$	$1\frac{3}{8}$	$1\frac{21}{32}$	$2\frac{1}{32}$	$\frac{7}{8}$	$\frac{13}{16}$
1	8	.837	.0156	.785	.550	$1\frac{5}{8}$	$1\frac{9}{16}$	$1\frac{7}{8}$	$2\frac{19}{64}$	1	$\frac{15}{16}$
$1\frac{1}{8}$	7	.940	.0178	.994	.694	$1\frac{13}{16}$	$1\frac{3}{4}$	$2\frac{3}{32}$	$2\frac{9}{16}$	$1\frac{1}{8}$	$1\frac{1}{16}$
$1\frac{1}{4}$	7	1.065	.0178	1.227	.893	2	$1\frac{15}{16}$	$2\frac{5}{16}$	$2\frac{53}{64}$	$1\frac{1}{4}$	$1\frac{3}{16}$
$1\frac{3}{8}$	6	1.160	.0208	1.485	1.057	$2\frac{3}{16}$	$2\frac{1}{8}$	$2\frac{17}{32}$	$3\frac{3}{32}$	$1\frac{3}{8}$	$1\frac{5}{16}$
$1\frac{1}{2}$	6	1.284	.0208	1.767	1.295	$2\frac{3}{8}$	$2\frac{5}{16}$	$2\frac{3}{4}$	$3\frac{23}{64}$	$1\frac{1}{2}$	$1\frac{7}{16}$
$1\frac{5}{8}$	$5\frac{1}{2}$	1.389	.0227	2.074	1.515	$2\frac{9}{16}$	$2\frac{1}{2}$	$2\frac{31}{32}$	$3\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{9}{16}$
$1\frac{3}{4}$	5	1.491	.0250	2.405	1.746	$2\frac{3}{4}$	$2\frac{11}{16}$	$3\frac{3}{16}$	$3\frac{57}{64}$	$1\frac{3}{4}$	$1\frac{11}{16}$
$1\frac{7}{8}$	5	1.616	.0250	2.761	2.051	$2\frac{15}{16}$	$2\frac{7}{8}$	$3\frac{13}{32}$	$4\frac{5}{32}$	$1\frac{7}{8}$	$1\frac{13}{16}$
2	$4\frac{1}{2}$	1.712	.0277	3.142	2.302	$3\frac{1}{8}$	$3\frac{1}{16}$	$3\frac{5}{8}$	$4\frac{27}{64}$	2	$1\frac{15}{16}$
$2\frac{1}{4}$	$4\frac{1}{2}$	1.962	.0277	3.976	3.023	$3\frac{1}{2}$	$3\frac{7}{16}$	$4\frac{1}{16}$	$4\frac{61}{64}$	$2\frac{1}{4}$	$2\frac{3}{16}$
$2\frac{1}{2}$	4	2.176	.0312	4.909	3.719	$3\frac{7}{8}$	$3\frac{13}{16}$	$4\frac{1}{2}$	$5\frac{31}{64}$	$2\frac{1}{2}$	$2\frac{7}{16}$
$2\frac{3}{4}$	4	2.426	.0312	5.940	4.620	$4\frac{1}{4}$	$4\frac{3}{16}$	$4\frac{29}{32}$	6	$2\frac{3}{4}$	$2\frac{11}{16}$
3	$3\frac{1}{2}$	2.629	.0357	7.069	5.428	$4\frac{5}{8}$	$4\frac{9}{16}$	$5\frac{3}{8}$	$6\frac{17}{32}$	3	$2\frac{15}{16}$
$3\frac{1}{4}$	$3\frac{1}{2}$	2.879	.0357	8.296	6.510	5	$4\frac{15}{16}$	$5\frac{13}{16}$	$7\frac{1}{16}$	$3\frac{1}{4}$	$3\frac{3}{16}$
$3\frac{1}{2}$	$3\frac{1}{4}$	3.100	.0384	9.621	7.548	$5\frac{3}{8}$	$5\frac{5}{16}$	$6\frac{7}{64}$	$7\frac{39}{64}$	$3\frac{1}{2}$	$3\frac{7}{16}$
$3\frac{3}{4}$	3	3.317	.0413	11.045	8.641	$5\frac{3}{4}$	$5\frac{11}{16}$	$6\frac{21}{32}$	$8\frac{1}{8}$	$3\frac{3}{4}$	$3\frac{11}{16}$
4	3	3.567	.0413	12.566	9.963	$6\frac{1}{8}$	$6\frac{1}{16}$	$7\frac{3}{32}$	$8\frac{41}{64}$	4	$3\frac{15}{16}$
$4\frac{1}{4}$	$2\frac{7}{8}$	3.798	.0435	14.186	11.329	$6\frac{1}{2}$	$6\frac{7}{16}$	$7\frac{9}{16}$	$9\frac{3}{16}$	$4\frac{1}{4}$	$4\frac{3}{16}$
$4\frac{1}{2}$	$2\frac{3}{4}$	4.028	.0454	15.904	12.753	$6\frac{7}{8}$	$6\frac{13}{16}$	$7\frac{31}{32}$	$9\frac{3}{4}$	$4\frac{1}{2}$	$4\frac{7}{16}$
$4\frac{3}{4}$	$2\frac{5}{8}$	4.256	.0476	17.721	14.226	$7\frac{1}{4}$	$7\frac{3}{16}$	$8\frac{13}{32}$	$10\frac{1}{4}$	$4\frac{3}{4}$	$4\frac{11}{16}$
5	$2\frac{1}{2}$	4.480	.0500	19.635	15.763	$7\frac{5}{8}$	$7\frac{9}{16}$	$8\frac{27}{32}$	$10\frac{49}{64}$	5	$4\frac{15}{16}$
$5\frac{1}{4}$	$2\frac{1}{2}$	4.730	.0500	21.648	17.572	8	$7\frac{15}{16}$	$9\frac{9}{32}$	$11\frac{23}{64}$	$5\frac{1}{4}$	$5\frac{3}{16}$
$5\frac{1}{2}$	$2\frac{3}{8}$	4.953	.0526	23.758	19.267	$8\frac{3}{8}$	$8\frac{5}{16}$	$9\frac{23}{32}$	$11\frac{7}{8}$	$5\frac{1}{2}$	$5\frac{7}{16}$
$5\frac{3}{4}$	$2\frac{3}{8}$	5.203	.0526	25.967	21.262	$8\frac{3}{4}$	$8\frac{11}{16}$	$10\frac{5}{32}$	$12\frac{3}{8}$	$5\frac{3}{4}$	$5\frac{11}{16}$
6	$2\frac{1}{4}$	5.423	.0555	28.274	23.098	$9\frac{1}{8}$	$9\frac{1}{16}$	$10\frac{19}{32}$	$12\frac{15}{16}$	6	$5\frac{15}{16}$

WEIGHTS OF BOLTS PER HUNDRED

SQUARE HEADS AND NUTS.

Dimensions in Inches.

Diameter.	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Length.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
1 1/2	9.7	20.4	37.0	58.0						
1 3/4	10.5	21.3	37.9	60.8						
2	11.3	22.4	39.9	63.2	97.7	145				
2 1/4	12.1	23.6	42.0	66.0	101.6	149				
2 1/2	12.9	25.0	44.4	69.0	105.6	153				
2 3/4	13.7	26.4	46.2	72.1	109.7	158				
3	14.5	27.8	48.3	75.2	113.8	163	240	309	350	480
3 1/2	16.1	30.6	52.5	81.4	122.0	174	253	325	370	500
4	17.7	33.4	56.7	87.6	130.2	185	267	342	390	520
4 1/2	19.2	36.2	60.9	93.8	138.4	196	281	359	410	545
5	20.7	39.0	65.1	100.0	146.4	207	295	376	430	570
5 1/2	22.2	41.8	69.2	106.1	154.9	218	309	394	450	595
6	23.7	44.6	73.4	112.2	163.2	229	323	412	470	620
6 1/2	25.2	47.4	77.6	118.3	171.5	240	337	430	490	645
7	26.7	50.2	81.8	124.4	179.8	251	351	448	510	670
7 1/2	28.2	53.1	86.0	130.5	187.1	262	365	466	530	695
8	29.7	56.0	90.0	136.6	195.4	273	379	484	550	725
9	33.1	61.5	98.0	148.8	212.0	295	407	518	590	775
10	36.5	67.0	106.3	161.0	229.0	317	435	552	630	825
11	40.0	72.5	114.6	173.2	246.0	339	463	586	670	875
12	43.5	78.0	122.9	184.4	263.0	361	491	620	710	925
Additional per Inch. Increase in Length	3.1	5.5	8.7	12.5	17.0	22.2	28.1	34.8	42.0	50.0
	Amount to be deducted from weights in table if Hexagon Heads and Nuts are used.									
	1.2	3.6	5.3	12.0	15.0	21.0	31.0	42.0	50.0	64.0

WEIGHT OF BRIDGE RIVETS PER 100.

THIS TABLE ALSO APPLIES TO BUTTON-HEADED BOLTS.

Diameter of Rivet in Inches.	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
Length of Rivet Under Head in Inches.	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*
1 1/4	5.7	12.8	22.0	29.3	43.9	66.6	93.3	127.1
1 3/8	6.1	13.5	23.1	30.9	46.1	69.4	96.9	131.5
1 1/2	6.5	14.2	24.1	32.4	48.2	72.1	100.4	135.8
1 5/8	6.9	14.8	25.2	34.0	50.3	74.9	103.9	140.2
1 3/4	7.3	15.5	26.3	35.5	52.5	77.7	107.4	144.5
1 7/8	7.7	16.2	27.4	37.1	54.6	80.5	110.9	148.9
2	8.0	16.9	28.5	38.7	56.7	83.3	114.5	153.2
2 1/8	8.4	17.6	29.6	40.2	58.8	86.0	118.0	157.5
2 1/4	8.8	18.3	30.7	41.8	61.0	88.8	121.5	161.9
2 3/8	9.2	19.0	31.7	43.3	63.1	91.6	125.0	166.2
2 1/2	9.6	19.7	32.8	44.9	65.2	94.4	128.5	170.6
2 5/8	10.0	20.4	33.9	46.5	67.4	97.2	132.1	174.9
2 3/4	10.4	21.1	35.0	48.0	69.5	99.9	135.6	179.3
2 7/8	10.8	21.8	36.1	49.6	71.6	102.7	139.1	183.6
3	11.2	22.5	37.2	51.1	73.7	105.5	142.6	188.0
3 1/8	11.6	23.2	38.3	52.7	75.9	108.3	146.1	192.3
3 1/4	11.9	23.9	39.3	54.3	78.0	111.1	149.7	196.7
3 3/8	12.3	24.6	40.4	55.8	80.1	113.8	153.1	201.0
3 1/2	12.7	25.3	41.5	57.4	82.3	116.6	156.7	205.4
3 5/8	13.1	26.0	42.6	58.9	84.4	119.4	160.2	209.7
3 3/4	13.5	26.7	43.7	60.5	86.5	122.2	163.7	214.1
3 7/8	13.9	27.4	44.8	62.1	88.6	125.0	167.3	218.4
4	14.3	28.1	45.9	63.6	90.8	127.8	170.8	222.8
4 1/8	14.7	28.7	46.9	65.2	92.9	130.5	174.3	227.1
4 1/4	15.1	29.4	48.0	66.7	95.0	133.3	177.8	231.4
4 3/8	15.5	30.1	49.1	68.3	97.2	136.1	181.3	235.8
4 1/2	15.8	30.8	50.2	69.9	99.3	138.9	184.9	240.1
4 5/8	16.2	31.5	51.3	71.4	101.4	141.7	188.4	244.5
4 3/4	16.6	32.2	52.4	73.0	103.5	144.4	191.9	248.8
4 7/8	17.0	32.9	53.5	74.5	105.7	147.2	195.4	253.2
5	17.4	33.6	54.5	76.1	107.8	150.0	198.9	257.5
5 1/4	18.2	35.0	56.7	79.2	112.1	155.6	206.0	266.2
5 1/2	19.0	36.4	58.9	82.3	116.3	161.1	213.1	274.9
5 3/4	19.7	37.8	61.1	85.5	120.6	166.7	220.1	283.6
6	20.5	39.2	63.2	88.6	124.8	172.2	227.1	292.3
7	23.6	44.7	71.9	101.1	142.0	194.5	255.3	327.1
8	26.8	50.3	80.6	113.7	158.9	216.7	283.4	361.9
9	29.9	55.9	89.3	126.2	175.9	239.0	311.6	396.6
10	33.0	61.4	98.0	138.7	193.0	261.2	339.7	431.4
12	39.3	72.5	115.4	163.7	227.0	305.7	367.9	501.0

WEIGHT OF TWO (2) RIVET HEADS IN POUNDS.

	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
Before driving..	.037	.116	.222	.273	.453	.78	1.16	1.67
After driving....	.032	.082	.147	.246	.369	.545	.746	1.02

WEIGHT OF BODY PER INCH OF LENGTH IN POUNDS.

	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
Before driving..	.031	.056	.087	.125	.170	.223	.282	.348

PENCOYD SPECIFICATIONS FOR RAILROAD BRIDGES.

Material.—1. All structures to be wholly of rolled steel (castings of iron or steel will be permitted only in machinery for draw-bridges).

Live Load.—2. They shall be designed to carry, in addition to their own weight and that of the floor, a moving load for each track, consisting of two engines coupled at the head of a uniformly distributed train load, placed so as to give the greatest strain in each part of the structure. This load will be such as specified by the Railroad Company and represented on a diagram accompanying the specifications.

Dead Load.—3. In determining the weight of the structure for the purpose of calculating strains, the weight of timber shall be assumed at 4½ pounds per foot B.M., and the weight of rails, spikes, and joints at 100 pounds per lineal foot of track.

Wind Pressure.—4. The wind pressure shall be assumed acting in either direction horizontally:

First. At 30 pounds per square foot on the exposed surface of all trusses and the floor as seen in elevation, in addition to a train of 10 feet average height, beginning 2 feet 6 inches above base of rail, moving across the bridge.

Second. At 50 pounds per square foot on the exposed surface of all trusses and the floor system. The greatest result shall be assumed in proportioning the parts.

5. For determining the requisite anchorage for the loaded structure, the train shall be assumed to weigh 800 pounds per lineal foot.

Momentum of Train.—6. For longitudinal bracing of trestle towers and similar structures, the momentum produced by suddenly stopping the train shall be considered, the coefficient of friction of wheels sliding upon the rails being assumed as 0.2.

Centrifugal Force of Train.—7. When the structure is on a curve, the additional effects due to the centrifugal force of as many trains as there are tracks, shall be considered and calculated by the following formula:

$C = 0.02\ W D$ for a curvature up to 5 degrees,

where $C =$ centrifugal force in pounds,
$W =$ weight of train in pounds,
$D =$ degree of curvature.

The coefficient for centrifugal force (0.02) shall be reduced 0.001 for every degree of curvature above 5 degrees.

PROPORTION OF PARTS.

Effect of Impact.—8. In proportioning the members of the structures, the effects of impact and vibration shall be considered and added to the maximum strains resulting from the above mentioned engine and train loads. The effect of impact is to be determined by the following formula:

$$I = S\left(\frac{300}{L + 300}\right)$$

(See Table, page 278.)

I = impact to be added to the live-load strain.
S = calculated maximum live-load strain.
where L = length of loaded distance in feet which produces the maximum strain in member.

Permissible Tensile Strains.—9. All parts of the structure shall be so proportioned that the sum of the maximum loads, together with the impact, shall not cause the tensile strain to exceed:

On soft steel, 15,000 pounds per square inch.
On medium steel, 17,000 pounds per square inch.

10. The same limiting unit strains shall also be used for members strained by wind pressure, centrifugal force, or momentum of train.

Permissible Compressive Strains.—11. For compression members, these permissible strains of 15,000 and 17,000 pounds per square inch, shall be reduced in proportion to the ratio of the length to the least radius of gyration of the section by the following formulæ:

For soft steel, $$p = \frac{15{,}000}{1 + \dfrac{l^2}{13{,}500r^2}}$$

For medium steel, $$p = \frac{17{,}000}{1 + \dfrac{l^2}{11{,}000r^2}}$$

p = permissible working strain per square inch in compression.
l = length of piece in inches, centre to centre of connection.
r = least radius of gyration of the section in inches.

(See Table.)

12. No compression member, however, shall have a length exceeding 100 times its least radius of gyration, excepting those for wind bracing, which may have a length not exceeding 120 times the least radius of gyration.

Alternate Strains.—13. Members subject to alternate strains of tension and compression, shall be so proportioned that the total sectional area is equal to the sum of areas required for each strain.

Combined Strains.—14. In case the maximum strains in chords of bridges, or posts of trestle towers, due to wind and centrifugal force, added to the maximum strains due to vertical loading, (including impact), shall exceed the following limits:

On soft steel, 19,000 pounds per square inch.

On medium steel, 21,000 pounds per square inch, properly reduced for compression, addition must be made to such members until these limits are not exceeded.

15. Should the strains be reversed in any possible case, proper provision must be made for such strains in the opposite direction.

Transverse Loading of Tension or Compression Members.—16. When the floor system rests directly on the top or bottom chord, the latter must be so proportioned that the algebraic sum of the strains per square inch on the outer fibre, resulting from

the direct compression or tension, and three-fourths of the maximum bending moment (the chord being considered as a beam of one panel length, supported at the ends), shall not exceed the before-mentioned limiting strains in tension or compression, the proper amount of impact being added to each kind of loading.

17. The bending moment at panel points shall be assumed equal to that in the centre, but in opposite direction.

18. All other members which are subject to direct strain in addition to bending moment are to be similarly calculated.

Shearing and Bearing Strains.—19. The shearing strain on rivets, bolts, or pins, per square inch of section, shall not exceed 11,000 pounds for soft steel, and 12,000 pounds for medium steel; and the pressure upon the bearing surface of the projected semi-intrados (diameter × thickness) of the rivet, bolt, or pin-hole, shall not exceed 22,000 pounds per square inch for soft steel, and 24,000 pounds for medium steel.

20. In case of field riveting by hand, the number of rivets thus found shall be increased 25 per cent.

Bending Strains on Pins.—21. The bending strain on the extreme fibre of pins shall not exceed 22,000 pounds per square inch for soft steel, and 25,000 pounds per square inch for medium steel, when the centres of bearings of the strained members are taken as the points of application of the strains.

22. Net sections must be used in all cases in calculating tension members, and, in deducting rivet-holes they must be taken $\frac{1}{8}$ of an inch larger than the size of the rivets.

Plate Girders.—23. No allowance shall be made for the web in calculating the flange sections of plate girders. The compressed flange shall have the same sectional area as the tension flange; but the unsupported length of flange shall not exceed twelve times its width.

24. In calculating shearing strains and bearing strains on web rivets of plate girders, the whole of the shear acting on the side of the panel next the abutment is to be considered as being transferred into the flange angles in a distance equal to the depth of the girder.

25. The shearing strain in web plates shall not exceed 9,000 pounds per square inch for soft steel, and 10,000 pounds per square inch for medium steel; but no web plate shall be less than $\frac{3}{8}$ of an inch in thickness.

26. The web shall have stiffeners riveted on both sides, with a close bearing against upper and lower flange angles at the ends and inner edges of bearing plates, and at all points of local and concentrated loads, and also, when the thickness of the web is less than $\frac{1}{60}$ of the unsupported distance between flange angles, at points throughout the length of the girder, generally not farther apart than the depth of the full web plate, with a maximum limit of 5 feet.

GENERAL DESCRIPTION.

Clearance.—27. On straight line a clear section shall be provided to conform to given requirements. The width must be increased so as to allow the same minimum clearance on curves and on double track.

Spacing of Trusses.—28. The width between centres of trusses shall in no case be less than $\frac{1}{20}$ of the span between centres of end pins.

Spacing of Stringers.—29. The floor stringers shall be placed generally 8 feet between centres for single track, and 6½ feet for double track bridges, the standard distance between centres of tracks being 13 feet.

Wooden Floor.—30. The floor shall consist of cross-ties 8 inches by 8 inches if the stringers are placed 6½ feet between centres, and 8 inches by 10 inches if the stringers are 8 feet between centres. They shall be spaced with openings not exceeding 6 inches, and shall be notched down ½ inch, and have a full and even bearing on stringers.

31. Every fifth tie shall be fastened to the stringer by a ¾-inch bolt.

32. In case of deck bridges, with ties resting on the upper chord, when the distance between centres of trusses exceeds 8 feet, the ties are to be proportioned to carry the maximum wheel load distributed over three ties, the fibre strain on the timber not to exceed 1,000 pounds per square inch.

Plate Girders.—33. Deck-plate girders shall be spaced generally 6½ feet between centres.

34. In through-plate girders, the floor stringers shall be spaced 6½ feet between centres.

Guard Rails.—35. There shall be guard timbers 6 inches by 8 inches on each side of each track, with their inner faces not less than 3 feet 3 inches from centre of track. They shall be notched 1 inch over every tie, and shall be fastened to every third tie and at each splice by a ¾-inch bolt. Splices shall be over floor timbers with half-and-half joints of 4 inches lap.

36. The floor timbers and guards must be continued over piers and abutments.

37. On curves the outer rails shall be elevated as may be required.

Strain Sheets.—38. Complete strain sheets, showing sectional areas and dimensions of all the parts, will be submitted with every proposal.

DETAILS OF CONSTRUCTION.

Adjustable Members.—39. Adjustable members in any parts of structures shall preferably be avoided.

Lateral and Sway Bracing.—40. All lateral and sway bracing shall be made of shapes which can resist tension as well as compression.

Portals.—41. All through spans with top lateral bracing shall have portals at each end of span, connected rigidly to end-posts. They shall be as deep as the specified head room will allow, and provision shall be made in the end-posts for the bending strain produced by the wind pressure.

Diagonal Bracing.—42. Deck bridges shall have diagonal braces at each panel of sufficient strength to carry half the maximum strain-increment due to wind and centrifugal force.

Pony Trusses.—43. Pony trusses and through plate girders shall be stayed by knee braces or gusset plates at the ends, and at each floor beam or transverse strut.

Floor Beam Connections.—44. All floor beams in through bridges shall be riveted between the posts, above or below the pin.

Expansion Rollers.—45. All bridges exceeding 100 feet in length shall have at one end nests of turned friction rollers, running between planed surfaces. Rollers shall not be less than 3 inches in diameter; and the pressure per lineal inch of roller, including impact, shall not exceed $1200 \sqrt{d}$ for steel rollers between steel surfaces ($d =$ diameter of roller in inches).

Friction Plates.—46. For bridges less than 100 feet in length, one end shall be free to move upon planed surfaces.

Truss Bridges.—47. Single-track bridges shall have lower chord end panels stiffened, and all through spans stiff and vertical suspenders.

Temperature.—48. Provision shall be made for a free expansion and contraction of all parts, corresponding to a variation of 150 degrees Fahrenheit in temperature.

Bed Plates.—49. Bed plates shall be so proportioned that the pressure upon masonry (including impact) will not exceed 400 pounds per square inch.

Web Splices.—50. Web plates of girders must be spliced at all joints by a plate on each side of the web, capable of transmitting the full shearing strain through splice rivets.

Rivets.—51. The pitch of rivets, in the direction of the strain, shall never exceed 6 inches, nor 16 times the thickness of the thinnest outside plate connected, and not more than 30 times that thickness at right angles to the strain.

52. At the ends of compression members the pitch shall not exceed four diameters of the rivet, for a length equal to twice the width of the member.

53. The distance from the edge of any piece to the centre of a rivet-hole must not be less than $1\frac{1}{2}$ times the diameter of the rivet, nor exceed 8 times the thickness of the plate; and the distance between centres of rivet-holes shall not be less than 3 diameters of the rivet.

Tie Plates.—54. All segments of compression members connected by latticing only, shall have tie plates placed as near the ends as practicable. They shall have a length of not less than the greatest depth or width of the member, and a thickness not less than $\frac{1}{50}$ of the distance between the rivets connecting them to the compressed members.

Lacing.—55. Single lattice bars shall have a thickness of not less than $\frac{1}{40}$, and double bars connected by a rivet at the intersection of not less than $\frac{1}{60}$ of the distance between the rivets connecting them to the member; and their width shall be:

For 15-inch channels, or built sections with $3\frac{1}{2}$- and 4-inch angles.	$2\frac{1}{2}$ inches ($\frac{7}{8}$-inch rivets).
For 12- and 10-inch channels, or built sections with 3-inch angles.	$2\frac{1}{4}$ inches ($\frac{3}{4}$-inch rivets).
For 9- and 8-inch channels, or built sections with $2\frac{1}{2}$-inch angles.	2 inches ($\frac{5}{8}$-inch rivets).

56. The distance between connections of the lattice bars shall not exceed 8 times the least width of the segments connected.

Pin Plates.—57. All pin-holes shall be re-enforced by additional material when necessary, so as not to exceed the allowed pressure

on the pins. These re-enforcing plates must contain enough rivets to transfer the proportion of pressure which comes upon them, and at least one plate on each side shall extend not less than 6 inches beyond the edge of the tie plate.

Joints.—58. All joints in riveted work, whether in tension or compression members, must be fully spliced. Pin connection, in riveted tension members shall have a section through the pin-hole 25 per cent. in excess of the net section of the body of the member. The section back of the pin-hole shall be at least 0.75 of the section through the pin-hole. The sections of compression chords shall be connected at the abutting ends by splices sufficient to hold them truly in position.

Least Thickness of Material.—59. For main members and their connections, no material shall be used less than $\frac{3}{8}$ of an inch thick; and for laterals and their connections, not less than $\frac{5}{16}$ of an inch thick except for lining or filling vacant spaces.

Eye-bar Heads.—60. The heads of eye-bars shall not be less in strength than the body of the bar.

Symmetrical Sections.—61. All sections shall preferably be made symmetrical, and the pins placed in the line of the neutral axis.

Camber.—62. All truss bridges with parallel chords shall be given a camber, by making the panel lengths of the top chord longer than those of the bottom chord in the proportion of $\frac{1}{8}$ of an inch to every 10 feet.

Nuts.—63. All nuts must be of hexagonal shape.

WORKMANSHIP.

Riveted Work.—64. All riveted work shall be punched accurately with holes $\frac{1}{16}$ of an inch larger than the size of the rivet; and when the pieces forming one built member are put together, the holes must be truly opposite; no drifting to distort the metal will be allowed; if the hole must be enlarged to admit the rivet, it must be reamed.

65. All holes for field rivets, excepting those in connections for lateral and sway bracing, shall be accurately drilled to an iron templet, or reamed while the connecting parts are temporarily put together.

Planing and Reaming.—66. In medium steel over $\frac{5}{8}$ of an inch thick all sheared edges shall be planed, and all holes shall be drilled or reamed to a diameter of $\frac{1}{8}$ of an inch larger than the punched holes, so as to remove all the sheared surface of the metal.

67. The rivet heads must be of approved hemispherical shape, and of a uniform size for the same size rivets throughout the work. They must be full and neatly finished throughout the work and concentric with the rivet-hole.

68. All rivets when driven must completely fill the holes, the heads be in full contact with the surface, or countersunk when so required.

69. Wherever possible, all rivets shall be machine-driven. Power riveters shall be direct-acting machines, worked by steam, hydraulic pressure, or compressed air, and capable of holding on to the rivet when upsetting is completed.

70. When members are connected by bolts which transmit shearing strains, the holes must be reamed parallel, and the bolts turned to a driving fit.

71. The several pieces forming one built member must fit closely together, and when riveted shall be free from twists, bends, or open joints.

72. All portions of the work exposed to view shall be neatly finished.

73. All surfaces in contact shall be painted before they are put together.

Forged Work.—74. The heads of eye-bars shall be made by upsetting, rolling, or forging into shape. Welds in the body of the bar will not be allowed.

Eye-bars.—75. The bars must be perfectly straight before boring.

76. The holes shall be in the centre of the head and on the centre line of the bar.

77. All eye-bars shall be annealed.

Machine Work.—78. All abutting surfaces in compression members shall be truly faced to even bearings, so that they shall be in such contact throughout, as may be obtained by such means.

79. The ends of floor girders shall be faced true and square.

80. Pin-holes shall be bored truly parallel with one another and at right angles to the axis of the member unless otherwise shown in drawings; and in pieces not adjustable for length, no variation of more than $\frac{1}{32}$ of an inch will be allowed in the length between centres of pin-poles.

81. Bars which are to be placed side by side in the structure shall be bored at the same temperature, and shall be of such equal length that, upon being piled on each other, the pins shall pass through the holes at both ends at the same time without driving.

82. All pins shall be accurately turned to a gauge, and shall be straight and smooth.

83. The clearance between pin and pin-hole shall be $\frac{1}{32}$ of an inch for all lateral pins; and for truss pins the clearance shall be $\frac{1}{50}$ of an inch for pins $3\frac{1}{2}$ inches in diameter, which amount shall be gradually increased to $\frac{1}{32}$ of an inch for pins 6 inches in diameter and over.

84. All pins shall be supplied with steel pilot nuts, for use during erection.

85. All workmanship shall be first class in every particular.

STEEL.

Process of Manufacture.—86. All steel must be made by the Open Hearth process, and if by acid process, shall contain not more than .08 per cent. of phosphorus, and if by basic process, not more than .05 per cent. of phosphorus, and must be uniform in character for each specified kind.

Finish.—87. The finished bars, plates, and shapes must be free from injurious seams, flaws, or cracks, and have a clean, smooth finish.

Test Pieces.—88. The tensile strength, limit of elasticity and ductility, shall be determined from a standard test-piece cut from the finished material, of at least $\frac{1}{2}$ square inch section. All broken samples must show a silky fracture of uniform color.

89. Every finished piece of steel shall be stamped with the blow number identifying the melt.

90. Steel shall be of two grades: *soft and medium.*

Soft Steel.—91. *Soft steel* shall have an ultimate strength of 50,000 to 60,000 pounds per square inch, elastic limit of one-half ultimate strength, and a minimum elongation of 26 per cent. in 8 inches. This steel must bend double to close contact, without sign of fracture on the outside.

Medium Steel.—92. *Medium steel* shall have an ultimate strength, when tested in samples of the dimensions above stated, of 60,000 to 70,000 pounds per square inch; an elastic limit of not less than one-half the ultimate strength, and a minimum elongation of 22 per cent. in 8 inches.

93. This steel must stand bending 180 degrees around a 2-inch pin without cracking on the convex surface, either cold, hot, or after being heated to a cherry red and cooled in water of 60 degrees Fahrenheit.

94. Full-sized eye-bars must elongate 10 per cent. in a gauged length of 10 feet, and break in the body of the bar.

Pin Steel.—95. Pins made of either of the above-mentioned grades of steel shall, on specimen test-pieces cut from finished material, fill the requirements of the grade of steel from which it is rolled, excepting the elongation, which shall be decreased 5 per cent. from that specified.

96. Punched rivet-holes, pitched two diameters from a sheared edge, must stand drifting until the diameter is one-third larger than the original hole, without cracking the metal.

97. All rivets will be made of soft steel, and the steel for rivets must bend double to close contact without cracking.

98. The slabs for rolling plates shall be hammered or rolled from ingots of at least twice their cross-section.

99. Pins up to 7 inches diameter shall be rolled.

100. Pins exceeding 7 inches diameter shall be forged under a steel hammer striking a blow of at least 5 tons. The blooms to be used for this purpose shall have at least three times the sectional area of the finished pins.

101. A variation in cross-section or weight of rolled material of more than $2\frac{1}{2}$ per cent. from that specified, may be cause for rejection.

Steel Castings.—102. Steel castings shall be made of Open Hearth steel containing from $\frac{25}{100}$ to $\frac{40}{100}$ per cent. carbon and not over $\frac{8}{100}$ per cent. of phosphorus, and shall be practically free from blow holes.

Cast Iron.—103. Except where chilled iron is specified, all castings shall be of tough, gray iron, free from injurious cold shuts or blow holes, true to pattern, and of workmanlike finish. Test bars 1 inch square, loaded in middle between supports 12 inches apart, shall bear 2,500 pounds or over, and deflect .15 of an inch before rupture.

Timber.—104. The timber shall be strictly first-class white pine, Southern yellow pine, or white oak bridge timber; sawed true and out of wind, full size, free from wind shakes, large or loose knots, decayed or sapwood, wormholes or other defects impairing its strength or durability.

PAINTING.

105. All iron work before leaving the shop shall be thoroughly cleaned from all loose scale and rust, and be given one good coating of pure boiled linseed oil, well worked into all joints and open spaces.

106. In riveted work, the surfaces coming in contact shall each be painted before being riveted together.

107. Pieces which are not accessible for painting after erection shall have two coats of paint.

108. The paint shall be of a good quality of iron ore paint, mixed with pure linseed oil, or such as may be specified in contract.

109. After the structure is erected, the iron work shall be thoroughly and evenly painted with two additional coats of paint, mixed with pure linseed oil, of such color as may be selected.

110. Pins, pin holes, screw threads, and other finished surfaces shall be coated with white lead and tallow before being shipped from the shop.

Inspection.—111. All facilities for inspection of material and workmanship shall be furnished by the contractor to competent inspectors, and the engineer and his inspectors shall be allowed free access to any part of the works in which any portion of the material is made.

112. The contractor shall furnish, without charge, such specimens (prepared) of the several kinds of material to be used as may be required to determine their character.

113. Full-sized parts of the structure may be tested at the option of the purchaser; but, if tested to destruction, such material shall be paid for at cost, less its scrap value, if it proves satisfactory.

114. If it does not stand the specified tests, it will be considered rejected material, and be solely at the cost of the contractor, unless he is not responsible for the design of the work.

C. C. SCHNEIDER,
Chief Engineer.

COEFFICIENTS OF IMPACT.

$L.$	$\frac{300}{L+300}$	$L.$	$\frac{300}{L+300}$	$L.$	$\frac{300}{L+300}$	$L.$	$\frac{300}{L+300}$	$L.$	$\frac{300}{L+300}$
5	0.984	31	0.906	57	0.840	83	0.783	145	0.674
6	0.980	32	0.904	58	0.838	84	0.781	150	0.667
7	0.977	33	0.901	59	0.836	85	0.779	155	0.659
8	0.974	34	0.898	60	0.833	86	0.777	160	0.652
9	0.971	35	0.896	61	0.831	87	0.775	165	0.645
10	0.968	36	0.893	62	0.829	88	0.773	170	0.638
11	0.965	37	0.890	63	0.826	89	0.771	175	0.632
12	0.962	38	0.888	64	0.824	90	0.769	180	0.625
13	0.958	39	0.885	65	0.822	91	0.767	185	0.619
14	0.955	40	0.882	66	0.820	92	0.765	190	0.612
15	0.952	41	0.880	67	0.817	93	0.763	195	0.606
16	0.949	42	0.877	68	0.815	94	0.761	200	0.600
17	0.946	43	0.875	69	0.813	95	0.759	210	0.588
18	0.943	44	0.872	70	0.811	96	0.758	220	0.577
19	0.940	45	0.870	71	0.809	97	0.756	230	0.566
20	0.937	46	0.867	72	0.806	98	0.754	240	0.556
21	0.935	47	0.865	73	0.804	99	0.752	250	0.546
22	0.932	48	0.862	74	0.802	100	0.750	260	0.536
23	0.929	49	0.860	75	0.800	105	0.741	270	0.526
24	0.926	50	0.857	76	0.798	110	0.732	280	0.517
25	0.923	51	0.855	77	0.796	115	0.725	290	0.508
26	0.920	52	0.852	78	0.794	120	0.714	300	0.500
27	0.917	53	0.850	79	0.792	125	0.706	400	0.429
28	0.915	54	0.847	80	0.789	130	0.698	500	0.375
29	0.912	55	0.845	81	0.787	135	0.690	600	0.333
30	0.909	56	0.843	82	0.785	140	0.682		

PERMISSIBLE COMPRESSIVE STRAINS.

p = strain allowed in pounds per square inch ; l = length ; r = least radius of gyration (both in inches).

$\frac{l}{r}$	FORMULA. Soft Steel. $p=\frac{15,000}{1+\frac{l^2}{13,500r^2}}$	FORMULA. Med. Steel. $p=\frac{17,000}{1+\frac{l^2}{11,000r^2}}$	$\frac{l}{r}$	FORMULA. Soft Steel. $p=\frac{15,000}{1+\frac{l^2}{13,500r^2}}$	FORMULA. Med. Steel. $p=\frac{17,000}{1+\frac{l^2}{11,000r^2}}$	$\frac{l}{r}$	FORMULA. Soft Steel. $p=\frac{15,000}{1+\frac{l^2}{13,500r^2}}$	FORMULA. Med. Steel. $p=\frac{17,000}{1+\frac{l^2}{11,000r^2}}$
10	14900	16850	50	12660	13850	90	9370	9790
12	14840	16780	52	12500	13650	92	9220	9610
14	14780	16710	54	12340	13440	94	9060	9420
16	14720	16610	56	12180	13230	96	8910	9240
18	14650	16510	58	12010	13020	98	8760	9080
20	14560	16410	60	11840	12810	100	8610	8910
22	14480	16290	62	11670	12600	102	8470	8740
24	14400	16150	64	11500	12390	104	8320	8570
26	14280	16020	66	11340	12180	106	8180	8410
28	14180	15870	68	11140	11970	108	8050	8250
30	14070	15710	70	11010	11760	110	7900	8100
32	13940	15550	72	10840	11550	112	7780	7940
34	13810	15380	74	10670	11350	114	7640	7790
36	13690	15210	76	10500	11150	116	7510	7650
38	13550	15030	78	10340	10950	118	7380	7500
40	13420	14840	80	10180	10750	120	7260	7360
42	13270	14650	82	10010	10550			
44	13120	14460	84	9850	10350			
46	12960	14260	86	9690	10160			
48	12820	14060	88	9530	9970			

APPENDIX.

The following pages contain some tables in frequent use by Engineers; also the physical properties of materials used in construction, not the product of the works.

These tables have been carefully compiled and corrected to conform to the latest knowledge on the respective subjects. All the materials described hereafter, offer a wide range of resistance to stress in any direction; and the tables for strengths indicate averages of reliable data.

In cases where two values are given, they belong to materials that vary considerably in quality; the figures applying to averages of the superior and inferior qualities respectively.

The tables for timber, see page 284, have been principally derived from experiments made under the direction of the Division of Forestry, U. S. Government testing machine at Watertown, and the Massachusetts Institute of Technology. For stones and other minerals, the U. S. Government tests are used, supplemented by other authoritative data. For the alloys, the results of experiments made at the Stephen's Institute for the U. S. Board for testing metals are used. The strength and elasticity of the copper alloys are very sensitive and subject to rapid fluctuation, due to minute changes of proportions and improper treatment in preparation. The figures given indicate a probable average, and individual cases may vary widely from them.

The results of many tests made at Pencoyd have been used to complete missing data or check statements that did not seem consistent.

When usual working loads are given, they accord with common practice under ordinary conditions, and in all cases are sufficiently low to embrace material not obviously unfit for use.

CAST-IRON.

FOUNDRY METALS.

The gray irons, ordinarily used for castings, are usually graded in this section as Nos. 1 and 2 foundry, and No. 3, or gray forge,* these classifications being determined by fracture at the furnace. Grades of higher number, which run mottled or white in fracture, are too hard for ordinary tool cutting, and *are only used for exceptional purposes in the foundry.*

By chemical analysis the gray irons are distinguished from the white by larger proportions of silicon and graphitic carbon in the former, while the latter grades contain more combined carbon.

There is usually associated with the iron, small proportions of manganese, sulphur, phosphorus, and sometimes other elements, which vary in amount and influence, according to the ores from which the metal is derived.

CHARACTERISTICS OF FOUNDRY IRONS.

No. 1. Softest grade, used for small castings, or mixed with large proportions of scrap for larger castings. In the pig, it shows a dark, open grain and rough fracture, and the free graphite is discernible. Tensile strength is low, the iron turns soft, and the cuttings separating in coarse fragments.

No. 2. Harder, and higher tensile strength than No. 1, and better adapted for large castings; bears a less proportion of scrap in mixture. The fracture is not as rough as No. 1, and shows a mixed, large and small dark grain; it turns harder, separating in finer fragments than No. 1.

No 3, or gray forge. Harder, and higher tensile strength, but more brittle than No. 2. Adapted for large castings requiring hard surfaces. Not adapted for small castings, in which it is apt to run white; will not usually bear any admixture of scrap. The grain is close, small and light gray, and sometimes shows white points, when approaching No. 4, or mottled in grade.

Cast-iron is quite variable in strength, especially in tensile resistance. In ordinary foundry iron, the tensile strength per square inch of section will vary from 14,000 to 20,000 pounds; and refined iron of high grade is known to run between 30,000 and 40,000 pounds tensile strength.

The elastic limit and modulus of elasticity are not distinctly defined, as some permanent set can be observed under working loads. For practical purposes in ordinary iron the elastic limit can be called about 6,000 pounds, and the modulus of elasticity 15,000,000 pounds per square inch of section. Under compression, when not accompanied with bending strains, ordinary cast-iron will bear from 90,000 to 130,000 pounds per square inch, usually assumed at an average of 100,000 pounds.

In test bars, cast 1 inch square of a fair quality of foundry iron for machinery castings, the tensile strength should be about 16,000 pounds per square inch of section, and the same bars tested transversely, between supports 12 inches apart, and load in middle should endure 2,500 pounds and deflect 0.15 inches.

---

*In some places this is subdivided, giving another grade of No. 3 Foundry Iron.

The shrinkage in casting will vary from .05 to .12 inches per foot of length. General average = .08 inches. Specific gravity averages 7.2. Weight per cubic inch, .26 pounds, or per cubic foot = 450 pounds.

PHYSICAL PROPERTIES OF TIMBER.

The physical properties of timber, given hereafter, are derived largely from the recent experiments of the Forestry Division, U. S. Department of Agriculture, which form the most complete and systematic series on record. The following general conclusions seem to be demonstrated:

1. That bleeding (the experiments were made on long leaf yellow pine) has no material effect on the strength of timber, the flexibility is slightly increased, but the bled timber will probably endure exposure to the weather as well as the other.

2. That moisture reduces the strength of timber, whether that moisture be the sap, or water absorbed after seasoning. In general, seasoned timber, or with not more than 12 per cent. moisture, is from 75 per cent. to 100 per cent. stronger than green timber.

3. When artificially dried, timber contains a uniform percentage of moisture throughout, a condition requiring months or even years to attain in air-dried heavy timber.

When kiln-dried at usual temperatures, wood shows no loss of strength compared with air-dried timber of the same percentage of moisture. The effect of very high temperatures and pressures (as used in vulcanizing) is lower strengths than when air-dried.

4. Large timbers are equal in strength per square inch of section, tested every way, to small timbers, provided they are equally sound and contain the same percentage of moisture.

5. The tests seem to indicate that the strength of woods of uniform structure increases with the specific gravity irrespective of species, *i. e.*, in general, the heaviest wood is the strongest. Oak seems not to belong to the list of woods to which this general remark applies.

The data on properties of timbers, given on page 284, must be used with considerable judgment and caution. Seasoned wood will gain weight, to the extent of 5 to 15 per cent., if exposed to the weather and this excess will be reduced if the wood is kept a week in a warm dry place.

Some of the individual tests made by the U. S. Forestry Division varied considerably from the mean values given in the table. In the case of tension tests, which varied most from the average, a few were as low as 25 per cent., while others reached 190 per cent. of the mean.

The elastic limit given in connection with the data from the U. S. Forestry Division, is the relative elastic limit suggested by Professor Johnson, as there is no definite "elastic limit" in timber similar to that in some metals. This relative elastic limit is taken where the rate of deflection is 50 per cent. more than it is under initial loads.

Modulus of ultimate bending is extreme fibre stress on beam at rupture. The modulus of elastic bending is the fibre stress when the rate of deflection is increased 50 per cent. The modulus of elasticity is derived from transverse tests.

WOODEN BEAMS AND PILLARS.

The table on page 286 gives the safe loads in pounds, uniformly distributed for rectangular wooden beams 1 inch thick, and is based on the experiments of the U. S. Forestry Division. As short beams have been found by experiment to fail by longitudinal shearing, the shorter lengths, marked with a *star*, have been calculated to resist this action. The working values of the shearing resistance per square inch being taken for well-seasoned sound timber as follows: Hemlock, 80 pounds; spruce, white pine and yellow pine (Southern), 120 pounds; oak, 200 pounds. The values in the table calculated for cross-bending, are based on the following extreme fibre stresses per square inch.

Hemlock, 750 pounds; white pine or spruce, 900 pounds; oak, 1200 pounds; yellow pine, 1500 pounds.

The table on page 287 gives the concentrated central loads, and is also computed from the foregoing data.

PILLARS.

The formulæ heretofore proposed for resistance of the wooden pillars, are not sustained by the results of recent experiments, such as those made in 1882 at the Watertown Arsenal. These were on white and yellow pine, partly seasoned, and indicate the following average breaking loads in pounds per sq. inch of section for the given ratios of length to thickness.

Ratio of Length of Thickness.	10	15	20	25	30	35	40	45	50	55	60
Yellow Pine	4400	4275	4100	3875	3600	3275	2900	2475	2130	1760	1480
White Pine	2450	2390	2300	2190	2050	1890	1700	1490	1320	1090	910
Hemlock	2200	2150	2050	1950	1850	1700	1530	1340	1190	980	820

The table given on page 288 for wooden pillars, is based on the above, corrected for seasoning, and taking one-eighth of the mean breaking loads as the safe working loads. Tests made of two or three sticks bolted and keyed together, showed that they did not behave like a solid pillar, but as if the several timbers acted independently. Composite wooden pillars should be treated as an aggregation of independent members.

PHYSICAL PROPERTIES OF WOOD.

Seasoned timber, moisture 12 per cent. and under.
Stresses given in pounds per square inch.

NAME OF MATERIAL.	*Ultim. Resist. to Tension.*	*Ultim. Resist. to Comp. Length.*	*Ultim. Resist. to Comp. Cross.*	*Ultim. Resist. to Shear L'gth.*
Ash (American)	17000	7200	1900	1100
Birch	15000	8000	. .	. .
Box	20000	10300	. .	. .
Cedar (White)	. . .	5200	700	400
Cedar (American Red)	10800	6000	. .	.
Chestnut	11500	5300	. .	. .
Cottonwood (see Poplar)	. . .	. . .	. .	. .
Douglas Spruce (Oregon Pine)	13000	5700	800	500
Fir	13000	. . .	. .	1300
Gum	. . .	7100	1400	800
Hemlock*	8700	5700	. .	400
Hickory (American) average	19600	9500	2700	1100
Lignum Vitæ	11800	9900	. .	. .
Mahogany (Spanish)	14900	8200	. .	. .
Maple	11150	7150	1800	500
Oregon Pine (see Douglas Spruce)	. . .	. . .	. .	. .
Oak (Red)	10250	7200	2300	1100
Oak (Black or Yellow)	10000	7300	1800	1100
Oak (White)	13600	8500	2200	1000
Oak (Live)	. . .	10400	. .	. .
Pine (Southern Yellow, long leafed)	13000	8000	1260	835
Pine (Cuban)	13000	8700	1200	770
Pine (Loblolly)	13000	7400	1150	800
Pine (White)	10000	5400	700	400
Poplar	7000	5000	. .	. .
Spruce (Northern)	11000	6000	. .	400
Spruce Pine (Pinus glabra of So. States)	12000	7300	1200	800
Walnut (Black)	10500	7500	2500	. .

Weight in Pounds per Cubic Foot of other Woods.

Cherry	42.
Cork	15.6
Ebony	76.1

***Individual tests of Hemlock seem to indicate a wood equal to White Pine,**

PHYSICAL PROPERTIES OF WOOD.

Seasoned timber, moisture 12 per cent. and under.
Stresses given in pounds per square inch.

Ultim. Resist. to Shear. Cross.	*Elastic Limit.*	*Modulus of Elasticity.*	*Modul. of Ultim. Bend'g.*	*Modul. of Elastic Bend'g.*	*Ordinary Working Stress.*			*Weight in Lbs. per Cu. Ft.*
					Tens.	*Comp.*	*Trans.*	
6280	7900	1640000	10800	7900	2000	1000	1200	39
5600	. . .	1645000	11700	. . .	2000	1000	1200	33
.	. . .	. . . .	. . .	. . .	2500	1200	1500	. .
1370	5800	910000	6300	5800	1200	600	800	23
. . .	. . .	. . . .	7200	. . .	1400	700	900	. .
1530	. . .	1140000	8100	. . .	1400	600	900	41
. . .	. . .	. . . .	. . .	. . .	. . .	. . .	. . .	. .
. . .	6400	1680000	7900	6400	1400	700	1000	32
. . .	. . .	1530000	. . .	. . .	. . .	. . .	. . .	. .
5890	7800	1700000	9500	7800	1200	900	900	37
2750	. . .	. . . .	7100	. . .	. . .	. . .	750	25
6000	11200	2390000	16000	11000	2000	1200	1800	50
. . .	. . .	. . . .	11700	. . .	1500	1200	1500	83
. . .	. . .	1255000	9550	. . .	1500	1200	1500	53
6350	. . .	. . . .	10000	. . .	. . .	. . .	. . .	49
. . .	. . .	. . . .	. . .	. . .	. . .	. . .	. . .	. .
. . .	9200	1970000	11400	9200	1400	900	1200	45
. . .	8100	1740000	10800	8100	1400	900	1200	45
4400	9600	2090000	13100	9600	1700	1000	1500	50
8480	9040	1851500	11300	. . .	. . .	. . .	. . .	. .
5600	10000	2070000	12600	9500	1600	1000	1500	38
. . .	11100	2370000	13600	10640	. . .	. . .	. . .	. .
. . .	9200	2050000	11300	9400	1600	900	1200	33
2500	6400	1390000	7900	6400	1200	700	900	24
. . .	. . .	. . . .	6500	. . .	900	600	750	. .
3250	. . .	1400000	8000	. . .	1200	700	900	26
. . .	8400	1640000	10000	8400	1200	700	900	30
4700	5700	1306000	8000	. . .	1000	1000	900	38

Weight in Pounds per Cubic Foot of other Woods.

Elm	35
Mahogany (Honduras)	35
Sycamore	37

but owing to frequent spiral growth of the wood it is not safe to so consider it.

GREATEST SAFE LOAD UNIFORMLY DISTRIBUTED FOR RECTANGULAR WOODEN BEAMS 1 INCH THICK.

(For explanation of table see page 283.)

Depth. Ins.	*Kind of Timber.*	*LENGTH OF SPAN IN FEET.*									
		4	6	8	10	12	14	16	18	20	22
		Safe Loads in Pounds per Inch of Thickness									
5	Hemlock.	520	350	260	210	170	150	130	120	100	90
	Spruce or Pine	620	420	310	250	210	180	160	140	120	110
	Oak.	830	550	420	330	280	240	210	190	170	150
	Yellow Pine.	*800	700	520	420	350	300	260	230	210	190
6	Hemlock.	*640	500	380	300	250	210	190	170	150	140
	Spruce or Pine	900	600	450	360	300	260	220	200	180	160
	Oak.	1200	800	600	480	400	340	300	270	240	220
	Yellow Pine.	*960	*960	750	600	500	430	370	330	300	270
7	Hemlock.	*750	680	510	410	340	290	260	230	200	190
	Spruce or Pine	*1120	820	610	490	410	350	310	270	240	220
	Oak.	1630	1090	820	650	540	470	410	360	330	300
	Yellow Pine.	*1120	*1120	1020	820	680	580	510	450	410	370
8	Hemlock.	*850	*850	670	530	440	380	330	300	270	240
	Spruce or Pine	*1280	1060	800	640	530	460	400	360	320	290
	Oak.	*2130	1420	1070	850	710	610	530	470	430	390
	Yellow Pine.	*1280	*1280	*1280	1070	890	760	670	590	530	480
9	Hemlock.	*960	*960	840	670	560	480	420	370	340	310
	Spruce or Pine	*1440	1350	1010	810	670	580	510	450	400	370
	Oak.	*2400	1800	1350	1080	900	770	670	600	540	490
	Yellow Pine.	*1440	*1440	*1440	1350	1120	960	840	750	670	610
10	Hemlock.	*1070	*1070	1040	830	690	590	520	460	420	380
	Spruce or Pine	*1600	*1600	1250	1000	830	710	620	560	500	450
	Oak.	*2670	2220	1670	1330	1110	950	830	740	670	610
	Yellow Pine.	*1600	*1600	*1600	*1600	1390	1190	1040	930	830	760
12	Hemlock.	*1280	*1280	*1280	1200	1000	860	750	670	600	540
	Spruce or Pine	*1920	*1920	1800	1440	1200	1030	900	800	720	650
	Oak.	*3200	*3200	2400	1920	1600	1370	1200	1070	960	870
	Yellow Pine.	*1920	*1920	*1920	*1920	*1920	1710	1500	1330	1200	1090
14	Hemlock.	*1490	*1490	*1490	*1490	1360	1170	1020	900	820	740
	Spruce or Pine	*2240	*2240	*2240	1960	1630	1400	1220	1090	980	890
	Oak.	*3730	*3730	3270	2610	2180	1870	1630	1450	1310	1190
	Yellow Pine.	*2240	*2240	*2240	*2240	*2240	*2240	2040	1810	1630	1480
16	Hemlock.	*1710	*1710	*1710	*1710	*1710	1520	1330	1180	1070	970
	Spruce or Pine	*2560	*2560	*2560	2550	2130	1830	1600	1420	1280	1160
	Oak.	*4270	*4270	4270	3410	2840	2440	2130	1900	1710	1550
	Yellow Pine.	*2560	*2560	*2560	*2560	*2560	*2560	*2560	2370	2130	1940
18	Hemlock.	*1920	*1920	*1920	*1920	*1920	*1920	1690	1500	1350	1230
	Spruce or Pine	*2880	*2880	*2880	*2880	2700	2310	2030	1800	1620	1470
	Oak.	*4800	*4800	*4800	4320	3600	3090	2700	2400	2160	1960
	Yellow Pine.	*2880	*2880	*2880	*2880	*2880	*2880	*2880	*2880	2700	2450

GREATEST SAFE CENTRAL LOADS FOR RECTANGULAR WOODEN BEAMS 1 INCH THICK.

(For explanation of table see page 283.)

Depth. Ins.	Kind of Timber.	LENGTH OF SPAN IN FEET. 4	6	8	10	12	14	16	18	20	22
		Safe Loads in Pounds per Inch of Thickness.									
5	Hemlock.	260	170	130	100	90	75	65	60	50	45
	Spruce or Pine	310	210	160	120	100	90	80	70	60	55
	Oak.	420	280	210	170	140	120	100	95	85	75
	Yellow Pine.	520	350	260	210	170	150	130	120	100	95
6	Hemlock.	380	250	190	150	120	110	95	85	75	70
	Spruce or Pine	450	300	220	180	150	130	110	100	90	80
	Oak.	600	400	300	240	200	170	150	130	120	110
	Yellow Pine.	750	500	370	300	250	210	190	170	150	140
7	Hemlock.	510	340	260	200	170	150	130	110	100	95
	Spruce or Pine	610	410	310	240	200	170	150	140	120	110
	Oak.	820	540	410	330	270	230	200	180	160	150
	Yellow Pine.	1020	680	510	410	340	290	260	230	200	190
8	Hemlock.	670	440	330	270	220	190	170	150	130	120
	Spruce or Pine	800	530	400	320	270	230	200	180	160	150
	Oak.	1070	710	530	430	360	300	270	240	210	190
	Yellow Pine.	1330	890	670	530	440	380	330	300	270	240
9	Hemlock.	840	560	420	340	280	240	210	190	170	150
	Spruce or Pine	1010	670	510	400	340	290	250	220	200	190
	Oak.	1350	900	670	540	450	390	340	300	270	250
	Yellow Pine.	*1440	1120	840	670	560	480	420	370	340	310
10	Hemlock.	1040	690	520	420	350	300	260	230	210	190
	Spruce or Pine	1250	830	620	500	410	360	310	280	250	230
	Oak.	1670	1110	830	670	550	480	420	370	330	300
	Yellow Pine.	*1600	1390	1040	830	690	590	520	460	410	380
12	Hemlock.	*1280	1000	750	600	500	430	370	330	300	270
	Spruce or Pine	1800	1200	900	720	600	510	450	400	360	330
	Oak.	2400	1600	1200	960	800	690	600	530	480	440
	Yellow Pine.	*1920	*1920	1500	1200	1000	860	750	670	600	540
14	Hemlock.	*1490	1360	1020	820	680	580	510	450	410	370
	Spruce or Pine	*2240	1630	1220	980	810	700	610	540	490	440
	Oak.	3270	2180	1630	1310	1090	930	820	730	650	590
	Yellow Pine.	*2240	*2240	2040	1630	1360	1170	1020	910	810	740
16	Hemlock.	*1710	*1710	1330	1070	890	760	660	590	530	480
	Spruce or Pine	*2560	2130	1600	1280	1060	910	800	710	640	580
	Oak.	*4270	2840	2130	1710	1420	1220	1060	950	850	780
	Yellow Pine.	*2560	*2560	*2560	2130	1780	1520	1330	1180	1060	970
18	Hemlock.	*1920	*1920	1690	1350	1120	960	840	750	670	610
	Spruce or Pine	*2880	2700	2030	1620	1350	1160	1010	900	810	740
	Oak.	*4800	3600	2700	2160	1800	1540	1350	1200	1080	980
	Yellow Pine.	*2880	*2880	*2880	2700	2250	1930	1690	1500	1350	1230

TOTAL SAFE LOAD IN NET TONS FOR SQUARE PILLARS.

For Hemlock Pillars take $\frac{9}{10}$ of load for White Pine.

Hgt. in Feet.	*Kind of Timber.*	*SIDE OF SQUARE PILLAR IN INCHES.*									
		4	5	6	7	8	9	10	12	14	16
		Total Safe Load in Net Tons.									
6	Yellow Pine	7.3	11.8	17.3	23.8	31.3	39.8	49.3	71.3	97.3	127.3
	White Pine	4.5	7.2	10.5	14.4	18.9	24.0	29.7	42.9	58.5	76.5
7	Yellow Pine	7.1	11.6	17.1	23.6	31.1	39.6	49.1	71.1	97.1	127.1
	White Pine	4.4	7.1	10.3	14.3	18.7	23.6	29.5	42.8	58.4	76.4
8	Yellow Pine	6.8	11.3	16.8	23.3	30.8	39.3	48.8	70.8	96.8	126.8
	White Pine	4.2	6.9	10.2	14.1	18.6	23.7	29.4	42.6	58.2	76.2
9	Yellow Pine	6.5	11.0	16.5	23.0	30.5	39.0	48.5	70.5	96.5	126.5
	White Pine	4.1	6.8	10.1	14.0	18.5	23.6	29.3	42.5	58.1	76.1
10	Yellow Pine	6.2	10.7	16.2	22.7	30.2	38.7	48.2	70.2	96.2	126.2
	White Pine	3.9	6.6	9.9	13.8	18.3	23.4	29.1	42.3	57.9	75.9
11	Yellow Pine	5.8	10.3	15.8	22.3	29.8	38.3	47.8	69.8	95.8	125.8
	White Pine	3.7	6.4	9.7	13.6	18.1	23.2	28.9	42.1	57.7	75.7
12	Yellow Pine	5.4	9.9	15.4	21.9	29.4	37.9	47.4	69.4	95.4	125.4
	White Pine	3.5	6.2	9.5	13.4	17.9	23.0	28.7	41.9	57.5	75.5
13	Yellow Pine	5.0	9.5	15.0	21.5	29.0	37.5	47.0	69.0	95.0	125.0
	White Pine	3.3	6.0	9.3	13.2	17.7	22.8	28.5	41.7	57.3	75.3
14	Yellow Pine	4.5	9.0	14.5	21.0	28.5	37.0	46.5	68.5	94.5	124.5
	White Pine	3.0	5.7	9.0	12.9	17.4	22.5	28.2	41.4	57.0	75.0
15	Yellow Pine	3.9	8.4	13.9	20.5	27.9	36.4	45.9	67.9	93.9	123.9
	White Pine	2.8	5.5	8.8	12.7	17.2	22.3	28.0	41.2	56.8	74.8
16	Yellow Pine	3.4	7.9	13.4	19.9	27.4	35.9	45.4	67.4	93.4	123.4
	White Pine	2.5	5.2	8.5	12.4	16.9	22.0	27.7	40.9	56.5	74.5
17	Yellow Pine	2.5	7.3	12.8	19.3	26.8	35.3	44.8	66.8	92.8	122.8
	White Pine	1.7	4.9	8.2	12.1	16.6	21.7	27.4	40.6	56.2	74.2
18	Yellow Pine	2.3	6.7	12.2	18.7	26.2	34.7	44.2	66.2	92.2	122.2
	White Pine	1.5	4.6	7.9	11.8	16.3	21.4	27.1	40.3	55.9	73.9
19	Yellow Pine	2.1	6.0	11.5	18.0	25.5	34.0	43.5	65.5	91.5	121.5
	White Pine	1.4	4.2	7.6	11.4	15.9	21.0	26.7	39.9	55.6	73.5
20	Yellow Pine	1.9	5.3	10.8	17.3	24.8	33.3	42.8	64.8	90.8	120.8
	White Pine	1.2	3.9	7.2	11.1	15.6	20.7	26.4	39.6	55.2	73.2
21	Yellow Pine	1.7	2.6	10.1	16.6	24.1	32.6	42.1	64.0	90.1	120.1
	White Pine	1.1	1.7	6.8	10.7	15.2	20.3	26.0	39.2	54.8	72.8
22	Yellow Pine	1.5	2.4	9.3	15.8	23.3	31.8	41.3	63.3	89.3	119.3
	White Pine	1.0	1.6	6.4	10.3	14.8	19.9	25.6	38.8	54.4	72.4

TABLE OF PHYSICAL PROPERTIES OF METALS AND ALLOYS.

Stresses given in pounds per square inch.

NAME OF MATERIAL.			*Ultimate Resistance to Tension.*	*Ultimate Resistance to Compress.*	*Resistance to Bending.*	*Elastic Limit.*	*Coef. of Elasticity Millions.*	*Weight in Lbs. per Cu. Inch.*
Aluminium Bronze.								
10% Al. 90% Cu. (rolled) .			100000	. . .	. . .	60000	18.0	.282
1¼% " 98¾% " (cast). . .			26800	. . .	. . .	. . .	. .	. .
Brass and Bronze.								
Copper.	Tin.	Zinc.						
85	15	—	35500	95000	63000	20000	. .	.319
90	10	—	33000	75000	52000	. . .	14.0	.318
95	5	—	30000	52000	39000	16000	13.7	.317
90	—	10	30000	48000	24000	. . .	. .	.322
80	—	20	37000	65000	30000	10000	12.4	.316
70	—	30	43000	79000	36000	9100	14.0	.310
60	—	40	49000	75000	42000	16400	12.2	.308
50	—	50	24000	117400	48000	16900	11.6	.304
85	12½	2½	34500	. . .	62400	. . .	12.5	. .
70	10	20	31760	. . .	43500	. . .	14.5	. .
60	10	30	21500	. . .	30200	. . .	15.8	.
55	½	44½	68900	. . .	. . .	22000	. .	. .
Bronze, Manganese (cast).			71200	130000	. . .	*17700	. .	. .
" " (rolled)			100000	. . .	. . .	80000	. .	. .
" Phosphor			47700	. . .	. . .	21500	. .	. .
" Tobin (rolled) . .			79400	175000	41900	55400	. .	.296
Copper (cast)			24800	. . .	. . .	8000	18.0	. .
" (sheet)			32600	. . .	. . .	. . .	. .	. .
" wire annealed. . .			39800	. . .	. . .	25000	18.0	. .
Iron Cast (See page 281). .								
" wire annealed			45000	. . .	. . .	. . .	. .	. .
" " hard drawn . .			75000	. . .	. . .	27000	26.0	. .
" wrgt., rolled bars . .			50000	36000	. . .	30000	29.0	. .
" " " plates .			50000	. . .	. . .	30000	29.0	. .
Lead			2050	7350	. . .	1100	0.85	. .
Steel (See page 18)								
Tin			3500	6400	. . .	1670	4.6	. .
Zinc (cast)			5400	. . .	. . .	4050	. .	. .

* This was true elastic limit, the "yield point" or "apparent elastic limit" given by drop of beam was at 38,640 pounds.

PHYSICAL PROPERTIES OF MATERIALS OF MASONRY, ETC.

All stresses given in pounds per square inch. For working stresses see p. 291.

MATERIAL.		*Ultim. Crush. Strength*	*Trans-verse Strength*	*Modulus of Elas'y.*	*W'ght per cu. Foot.*
Brick, Flatwise Paving.	max.	20800	3100	4000000	150
	min.	4880	1350	2000000	
Paving Brick, Phila. Specifications.					
Red Shale		9090	5000		
		18000	6000		
Yellow Fire Clay.		8000	5800		
		10000	6200		
Hard Building	max.	18400	1250	4000000	125
	min.	3800	300	2000000	
Soft "		. . . .	. . . .	. . . .	100
Concretes, 1 month old, of following composition:					
Cement mortar, 1 of natural cem., 2 of sand		. . . .	. . . .	. . . .	109
Natural Cement Mortar and Furnace Slag		. . . .	. . . .	. . . .	120
" " " " Sandstone. .		. . . .	Concretes after		136
" " " " Limestone*. .		. . . .	6 months will be		142
" " " " Granite . .		250	about 4 times,		142
" " " " Trap . . .		to	and at the of 1		147
Cement Mortar, 1 of Portland cem., 2 of sand		500	year will be 6 to		134
Portland Cement Mortar and Furnace Slag		. . . .	7 times as strong		137
" " " " Sandstone. .		. . . .	as at the end of		153
" " " " Limestone*. .		. . . .	the first month.		159
" " " " Granite . . .		. . . .	. . . .	. . . .	159
" " " " Trap		. . . .	. . . .	. . . .	164
Granite	max.	24450	2700	13000000	164
	min.	12000	900	1620000	
Limestone.	max.	22300	2500	8000000	158
	min.	7000	150	335000	
Marble	max.	20000	2850	13550000	170
	min.	4650	150	2500000	
Sandstone	max.	18750	2350	2815000	139
	min.	4100	350	270000	
Slate.		. . . .	. . . .	7000000	174
Trap.		22000	. . . .	. . . .	170

WEIGHT IN POUNDS PER CUBIC FOOT OF SUBSTANCES.

Name of Substance.	*Pounds.*	*Name of Substance.*	*Pounds.*
Asphaltum	87	Lime, quick, of ord. limestone	95
Clay, potter's dry.	119	" " ground, loose	53
" in lump, loose.	63	Lime, quick, gro., well shaken	75
Earth, com. loam, dry, loose .	72—80	Mica	183
" " " " rammed	90—100	Mud, dry, close.	80—100
Flint.	162	" wet, fluid	104—120
Glass, common window. . .	157	Quartz, common, pure . . .	165
Gneiss	168	Salt, Syracuse, N. Y.	45
Gypsum.	142	Sand, dry and loose	90—106
" (plaster of Paris gr'd).	60	" perfectly wet	118—129
Ivory	114	Shales, red or black.	162

* It is claimed that the use of limestone for the body of concrete is attended with corrosion of the imbedded iron and it is obviously unfit for fire-proofing.

FOUNDATIONS.

The bearing power of soils varies widely with their nature and condition. Rock may sustain from 18 to 180 tons per square foot. Compact gravel and coarse sand well cemented, of considerable thickness, not liable to be carried away by water, can be loaded with 8 to 10 tons per square foot, while the stiff varieties of dry clay will safely support 4 to 6 tons per square foot. In general, however, the building laws of different localities will limit the pressure on the different soils. The table below gives the requirements of a few cities.

Bearing Material.	*Phila*	*N. Y.*	*Chic.*	*Buff.*	*Mil.*
	Load Net Tons per Sq. Ft.				
Solid natural earth of dry clay . . .	$2\frac{1}{2}$	. .	$1\frac{3}{4}$	$3\frac{1}{2}$	4
Clay moderately dry	. .	. .	. .	. .	2
Clay soft. (Confined).	. .	. .	. .	. .	1
Gravel and coarse sand well cemented	. .	. .	. .	. .	8
Gravel and sand	4	. .	.	4	. .
Clay and sand	. .	. .	$1\frac{1}{2}$	. .	. .
Dry sand. (Confined)	. .	. .	2	. .	. .
Dimension stone, beds dressed to uniform surface, cement, mortar joints under 1″.	. .	. .	5	7	. .
Concrete. (see page 290)	. .	. .	. .	4	. .
Rubble stone work in cement mortar	. .	. .	. .	5	. .
Common brick laid in lime mortar .	. .	.	. .	3	. .
Common brick laid in cement mortar	.	.	. .	5	. .
Hard burned brick in lime mortar	8	8	$6\frac{1}{2}$	6	. .
Hard burned brick in cement mortar	15	15	9	9	. .
First-class brick work in Portland cement mortar	. .	. .	$12\frac{1}{2}$	12	. .
Hard brick in lime and cement mortar mixed	12	$11\frac{1}{2}$	. .	. .	. .

Piles.	*Load Net Tons per Pile.*				
Philadelphia small end 5″ head 12″ spaced not over 30″ centre to centre	20	. .	. .	. .	. .
New York small end 5″ spaced not over 30″ centre to centre	. .	20	. .	. .	. .
Chicago	. .	. .	25	. .	. .
Buffalo small end 6″ spaced not over 36″ centre to centre	. .	. .	. .	25	. .

For Bearing Plates, see page 110.

PILES.

The driving requirements for piles in municipal work will be given in the local building laws, as also are the dimensions, loading and spacing as given on the preceding page. Their degree of stability under these conditions can be determined from the following formulæ:

L = load in net tons,
W = weight of hammer in net tons,
w = weight of hammer in pounds,
H = fall of hammer in feet,
h = fall of hammer in inches,
p = penetration in inches, due to last fall.

$$L = \frac{\sqrt[3]{H} \times w \times .026}{p+1} \qquad \text{(Trautwine.)}$$

As a factor, Trautwine recommends that for piles thoroughly driven in firm soils, one-half of the above load be taken, in river mud or marsh (piles not driven to rock-bottom), the safe load be restricted to one-sixth of L.

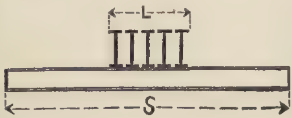
$$L = \frac{h \times W}{p \times 8} \qquad \text{(Sanders.)}$$

This formula applies to a pile driven until its penetration is small and nearly equal for successive blows.

$$L = \frac{2 \times w \times H}{p+1} \qquad \text{(Wellington.)}$$

GRILLAGE BEAMS.

Safe loads on Pencoyd **I** beams used in a grillage for foundations of walls or columns:



Considering the lower course, the supporting pressure from the soil is taken as uniformly distributed on the beams over the span S, while the load carried by the foundation is taken as uniformly distributed on beams over the span L. The maximum bending moment is then $\frac{1}{8} W (S - L)$ where W is the total load on the foundation.

To find the safe load that a beam will carry as a grillage beam, it is only necessary to refer to the tables of safe load on pages 30 to 95, and take the safe load the beam will carry for a span $(S - L)$.

Example.—Suppose a load of 500 net tons carried on a soil that will support safely 2 tons per square foot, the area required for the foundation will be 250 square feet. Taking the base of the column as 4 feet 6 inches square, 5 beams can be placed side by side in this width and permit of concrete being rammed between them. Then each beam will be loaded with 83 tons. The soil area covered by foundation will be a square of 16 feet side, hence $(S - L)$ is $16 - 4\frac{1}{2} = 11\frac{1}{2}$ feet. Now, on page 31, of safe loads of **I** beams, we find that a 24 inch **I** beam, 85 pounds, will carry 84 tons. In the same way the beams in the lower course are found to be 16—15 inch **I** beams, 50 pounds.

PAINT.

The covering property of paint depends on the smoothness or absorbing power of the surface painted; also on the fluidity of the paint. Ordinarily one gallon of paint, consisting of finely ground pigment and linseed oil, covers about 600 square feet of metallic surface one coat, or 350 square feet with two coats.

If the surface is very smooth and non-absorbent, or the paint is thinned with turpentine or naptha, the paint may spread over more surface to the extent of 50 per cent. If the contrary conditions exist, the surface covered may be diminished one-half. The volume of the mixed paint usually exceeds the volume of oil used from 20 to 75 per cent., according to the kind of pigment used.

AVERAGE SURFACE COVERED PER GALLON OF PAINT.

Paint.	*Volume of Oil.*	*Lbs. of Pigment.*	*Volume and Weight of Paint.*	*Square Feet.* 1 Coat.	*Square Feet.* 2 C'ts.
			Gals. Lbs.		
Iron Oxide (powdered) .	1 gal.	8.00	1.2=16.00	600	350
" " (ground in oil)	1 "	24.75	2.6=32.75	630	375
Red Lead (powdered) . .	1 "	22.40	1.4=30.40	630	375
White Lead (g'rd in oil) .	1 "	25.00	1.7=33.00	500	300
Graphite (ground in oil) .	1 "	12.50	2.0=20.50	360	215
Black Asphalt	1 " (turp.)	17.25	4.0=30.00	515	310
Linseed oil (no pigment) .	1 "	. . .	. . . . .	875	. . .

Light structural work will average about 250 square feet, and heavy structural work about 150 square feet of surface per net ton of metal.

The cost of painting with oxide of iron or similar material, based upon paint costing 50 cents per gallon, labor at shops, $1.50 per day, and at erection, $2.00 per day, will average:

COST PER NET TON.

	Light Work.		*Heavy Work.*	
One Coat at Shop:				
Cost of paint per net ton of steel	$0.27		$0.18	
Cost of labor per net ton of steel	0.18		0.12	
Total		$0.45		$0.30
Two Coats after Erection:				
Cost of paint per net ton of steel	$0.45		$0.30	
Cost of labor per net ton of steel	0.90		0.60	
Total		1.35		0.90
		$1.80		$1.20

Coating with tar at 300° F. requires 1 gallon of tar per 220 square feet of surface covered. The average cost, based upon tar at 10 cents per gallon, and labor at $1.50 per day, is as follows:

	Light Work.	*Heavy Work.*
Cost of tar per net ton of steel	$0.12	$0.07
Cost of labor, etc., per net ton of steel	0.68	0.38
Total	$0.80	$0.45

CRANE CHAINS.

DIMENSION.				"D. B. G." SPECIAL CRANE.			CRANE.		
Size of Chain. Inches.	*Pitch A. Approximately. Inches.*	*Weight per Foot in Pounds. Approximately.*	*Outside Width. B. Inches.*	*Proof Test. Pounds.*	*Average Breakage Strain. Pounds.*	*Ordinary Safe Load. General Use. Pounds.*	*Proof Test. Pounds.*	*Average Breaking Strain. Pounds.*	*Ordinary Safe Load. General Use. Pounds.*
$\frac{1}{4}$	$\frac{25}{32}$	$\frac{7}{8}$	$\frac{7}{8}$	1932	3864	1288	1680	3360	1120
$\frac{5}{16}$	$\frac{27}{32}$	1	$1\frac{1}{16}$	2898	5796	1932	2520	5040	1680
$\frac{3}{8}$	$\frac{31}{32}$	$1\frac{7}{10}$	$1\frac{1}{4}$	4186	8372	2790	3640	7280	2427
$\frac{7}{16}$	$1\frac{5}{32}$	2	$1\frac{3}{8}$	5796	11592	3864	5040	10080	3360
$\frac{1}{2}$	$1\frac{11}{32}$	$2\frac{1}{2}$	$1\frac{11}{16}$	7728	15456	5182	6720	13440	4480
$\frac{9}{16}$	$1\frac{15}{32}$	$3\frac{2}{10}$	$1\frac{7}{8}$	9660	19320	6440	8400	16800	5600
$\frac{5}{8}$	$1\frac{23}{32}$	$4\frac{1}{8}$	$2\frac{1}{16}$	11914	23828	7942	10360	20720	6907
$\frac{11}{16}$	$1\frac{27}{32}$	5	$2\frac{1}{4}$	14490	28980	9660	12600	25200	8400
$\frac{3}{4}$	$1\frac{31}{32}$	$5\frac{7}{8}$	$2\frac{1}{2}$	17388	34776	11592	15120	30240	10080
$\frac{13}{16}$	$2\frac{3}{32}$	$6\frac{7}{10}$	$2\frac{11}{16}$	20286	40572	13524	17640	35280	11760
$\frac{7}{8}$	$2\frac{7}{32}$	8	$2\frac{7}{8}$	22484	44968	14989	20440	40880	13627
$\frac{15}{16}$	$2\frac{15}{32}$	9	$3\frac{1}{16}$	25872	51744	17248	23520	47040	15680
1	$2\frac{19}{32}$	$10\frac{7}{10}$	$3\frac{1}{4}$	29568	59136	19712	26880	53760	17920
$1\frac{1}{16}$	$2\frac{23}{32}$	$11\frac{2}{10}$	$3\frac{5}{16}$	33264	66538	22176	30240	60480	20160
$1\frac{1}{8}$	$2\frac{27}{32}$	$12\frac{1}{2}$	$3\frac{3}{4}$	37576	75152	25050	34160	68320	22773
$1\frac{3}{16}$	$3\frac{5}{32}$	$13\frac{7}{10}$	$3\frac{7}{8}$	41888	83776	27925	38080	76160	25387
$1\frac{1}{4}$	$3\frac{7}{32}$	16	$4\frac{1}{8}$	46200	92400	30800	42000	84000	28000
$1\frac{5}{16}$	$3\frac{15}{32}$	$16\frac{1}{2}$	$4\frac{3}{8}$	50512	101024	33674	45920	91840	30613
$1\frac{3}{8}$	$3\frac{5}{8}$	$18\frac{4}{10}$	$4\frac{9}{16}$	55748	111496	37165	50680	101360	33787
$1\frac{7}{16}$	$3\frac{25}{32}$	$19\frac{7}{10}$	$4\frac{3}{4}$	60368	120736	40245	54880	109760	36587
$1\frac{1}{2}$	$3\frac{31}{32}$	$21\frac{7}{10}$	5	66528	133056	44352	60480	120960	40320

The distance from centre of one link to centre of next is equal to the inside length of link, but in practice $\frac{1}{32}$ inch is allowed for weld. This is approximate, and where exactness is required, chain should be made so.

For Chain Sheaves.—The diameter, if possible, should be not less than twenty times the diameter of chain used. *Example*—For 1-inch chain use 20-inch sheaves.

WROUGHT IRON TUBES.

Ordinary Gas or Water Pipe.								Hydraulic Tubing. Extra.		Hydraulic Tubing. Double Extra.	
Nominal Diameter.	*Outside Diameter.*	*Thickness.*	*Inside Diameter.*	*Internal Area.*	*External Area.*	*Weight per Foot.*	*Threads per Inch.*	*Thickness.*	*Inside Diameter.*	*Thickness.*	*Inside Diameter.*
1/8	.40	.07	.27	.06	.13	.24	27	.10	.20	—	—
1/4	.54	.09	.36	.10	.23	.42	18	.12	.29	—	—
3/8	.67	.09	.49	.19	.36	.56	18	.13	.42	.22	.23
1/2	.84	.11	.62	.30	.55	.84	14	.15	.54	.29	.24
3/4	1.05	.11	.82	.53	.87	1.12	14	.16	.73	.31	.42
1	1.31	.13	1.05	.86	1.36	1.67	11½	.18	.95	.36	.58
1¼	1.66	.14	1.38	1.49	2.15	2.24	11½	.19	1.27	.38	.88
1½	1.90	.15	1.61	2.03	2.84	2.68	11½	.20	1.49	.40	1.08
2	2.37	.15	2.07	3.35	4.48	3.61	11½	.22	1.93	.44	1.49
2½	2.87	.20	2.47	4.78	6.49	5.74	8	.28	2.31	.56	1.75
3	3.50	.22	3.07	7.38	9.62	7.54	8	.30	2.89	.60	2.28
3½	4.00	.23	3.55	9.89	12.57	9.00	8	.32	3.35	.64	2.71
4	4.50	.24	4.03	12.73	15.90	10.66	8	.34	3.81	.68	3.13
4½	5.00	.25	4.51	15.96	19.64	12.34	8	.35	4.25	.72	3.56
5	5.56	.26	5.05	19.99	24.30	14.50	8	.37	4.81	.75	4.06
6	6.63	.28	6.07	28.88	34.47	18.76	8	.44	5.75	.87	4.87
7	7.63	.30	7.02	38.73	45.66	23.27	8	.50	6.62	.84	6.06
8	8.63	.32	7.98	50.03	58.43	28.18	8	.56	7.50	.87	6.87
9	9.63	.34	8.94	62.73	73.72	33.70	8				
10	10.75	.36	10.02	78.84	90.76	40.06	8				
12	12.75	.38	12.00	113.09		49.00	8				
13	14.00	.38	13.25			53.92	8				
14	15.00	.38	14.25			57.89	8				

NOTE—Above 15 inches the outside diameters are the nominal size.
All dimensions given in inches, all weights in pounds.

CORRUGATED IRON 2½″ PITCH.

U. S. Standard Gauge.	Thickness of Sheet in Inches.	Weight of 100 Square Feet in Pounds.							
		Loose Sheets.		Galvanized Iron Laid, Adding for Laps—for Sheet Lengths of:					
		Black.	Galvanized.	5′	6′	7′	8′	9′	10′
20	.0375	167	184	210	208	207	206	206	205
22	.0313	139	156	178	176	176	175	174	174
24	.025	111	128	146	145	144	143	143	143
26	.0188	83	101	115	114	114	113	113	113

NOTE.—If material is to be painted add 2 pounds to the above weights of 100 square feet.

This table is based on galvanized corrugated sheets 27″ wide and ⅝″ deep, 2½″ centre to centre of corrugation.

Before corrugating, sheets are 30″ wide.

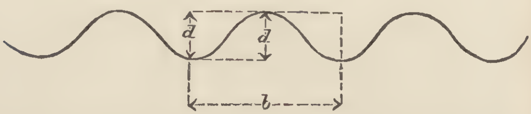


TABLE OF SAFE AND CRIPPLING LOADS IN POUNDS PER SQUARE FOOT.

U. S. Standard Gauge.	Safe Load.				Elastic Limit.				Crippling Load.			
	Span in Feet.				Span in Feet.				Span in Feet.			
	3	4	5	6	3	4	5	6	3	4	5	6
20	59	44	36	30	89	67	54	45	134	100	80	67
22	48	36	29	24	71	54	43	36	107	80	64	54
24	37	28	22	19	56	42	34	28	84	63	51	42
26	31	23	18	16	44	34	27	23	69	52	41	34

FORMULA:

$$W = \frac{98000\, t\, b\, d}{l}$$

W = Crippling load in pounds per square foot.
t = Thickness of metal in inches.
b = Centre to centre of corrugation in inches.
d = Depth of corrugation in inches.
l = Length of span in inches.

WEIGHT OF ROLLED SHEETS.

Calculations based on Specific Gravity of 7.85.

No. of Gauge.	*Birmingham Wire Gauge and English Standard Gauge.*		*American (B. & S.) Wire Gauge.*		*New U. S. Standard Gauge, 1873.*	
	Thickness in Inches.	*Weight per Sq. Ft.*	*Thickness in Inches.*	*Weight per Sq. Ft.*	*Thickness in Inches.*	*Weight per Sq. Ft.*
0000	.454	18.52	.460	18.76	.406	16.58
000	.425	17.34	.410	16.72	.375	15.30
00	.380	15.50	.365	14.88	.344	14.03
0	.340	13.87	.325	13.26	.313	12.75
1	.300	12.24	.289	11.80	.281	11.48
2	.284	11.59	.258	10.52	.266	10.84
3	.259	10.56	.229	9.36	.250	10.20
4	.238	9.71	.204	8.33	.234	9.56
5	.220	8.98	.182	7.42	.219	8.93
6	.203	8.28	.162	6.61	.203	8.29
7	.180	7.34	.144	5.88	.188	7.65
8	.165	6.73	.129	5.24	.172	7.01
9	.148	6.04	.114	4.66	.156	6.38
10	.134	5.47	.102	4.15	.141	5.74
11	.120	4.89	.091	3.70	.125	5.10
12	.109	4.44	.081	3.29	.109	4.46
13	.095	3.87	.072	2.93	.094	3.83
14	.083	3.38	.064	2.61	.078	3.19
15	.072	2.94	.057	2.32	.070	2.87
16	.065	2.65	.051	2.07	.063	2.55
17	.058	2.37	.045	1.84	.056	2.30
18	.049	1.99	.040	1.64	.050	2.04
19	.042	1.71	.036	1.46	.044	1.79
20	.035	1.42	.032	1.30	.038	1.53
21	.032	1.30	.028	1.16	.034	1.40
22	.028	1.14	.025	1.03	.031	1.28
23	.025	1.02	.023	0.921	.028	1.15
24	.022	0.898	.020	0.821	.025	1.02
25	.020	0.816	.018	0.729	.022	0.89
26	.018	0.734	.016	0.651	.019	0.77
27	.016	0.653	.014	0.581	.017	0.70
28	.014	0.571	.013	0.515	.016	0.64
29	.013	0.531	.011	0.459	.014	0.57
30	.012	0.489	.010	0.409	.013	0.51
31	.010	0.408	.009	0.364	.011	0.45
32	.009	0.367	.008	0.324	.010	0.41
33	.008	0.326	.007	0.288	.009	0.38
34	.007	0.286	.006	0.257	.009	0.35
35	.005	0.204	.006	0.228	.008	0.32
36	.004	0.162	.005	0.204	.007	0.29

WEIGHT OF STEEL PLATE.

Pounds per Lineal Foot.

Width in Inches.	*THICKNESS IN INCHES.*							
	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$
12	2.55	5.10	7.65	10.20	12.75	15.30	17.85	20.40
13	2.76	5.52	8.29	11.05	13.81	16.57	19.34	22.10
14	2.98	5.95	8.92	11.90	14.87	17.85	20.83	23.80
15	3.19	6.37	9.57	12.75	15.94	19.12	22.32	25.50
16	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20
17	3.61	7.22	10.84	14.45	18.06	21.67	25.28	28.91
18	3.82	7.65	11.47	15.30	19.12	22.95	26.77	30.60
19	4.04	8.08	12.11	16.15	20.18	24.22	28.26	32.29
20	4.25	8.50	12.75	17.00	21.25	25.50	29.75	34.00
21	4.47	8.92	13.39	17.85	22.32	26.77	31.24	35.70
22	4.67	9.35	14.02	18.70	23.38	28.05	32.72	37.40
23	4.88	9.77	14.67	19.55	24.44	29.32	34.21	39.11
24	5.10	10.20	15.30	20.40	25.50	30.60	35.70	40.80
25	5.31	10.63	15.93	21.25	26.56	31.87	37.19	42.49
26	5.53	11.05	16.57	22.10	27.62	33.15	38.68	44.20
27	5.74	11.47	17.22	22.95	28.69	34.42	40.17	45.90
28	5.95	11.90	17.85	23.80	29.75	35.70	41.65	47.60
29	6.16	12.32	18.49	24.65	30.81	36.97	43.13	49.31
30	6.37	12.75	19.12	25.50	31.87	38.25	44.62	51.00
32	6.80	13.60	20.40	27.20	34.00	40.80	47.60	54.40
34	7.22	14.45	21.67	28.90	36.13	43.35	50.57	57.79
36	7.65	15.30	22.95	30.60	38.25	45.90	53.55	61.20
38	8.08	16.15	24.22	32.30	40.38	48.45	56.53	64.61
40	8.50	17.00	25.50	34.00	42.50	51.00	59.50	67.99
42	8.92	17.85	26.77	35.70	44.62	53.55	62.47	71.40
44	9.35	18.70	28.05	37.40	46.76	56.10	65.45	74.81
46	9.77	19.55	29.32	39.10	48.88	58.65	68.42	78.19
48	10.20	20.40	30.60	40.80	51.00	61.20	71.40	81.60
50	10.63	21.25	31.87	42.49	53.12	63.75	74.37	85.00
52	11.05	22.10	33.15	44.20	55.25	66.30	77.35	88.39
54	11.47	22.95	34.42	45.90	57.37	68.85	80.32	91.80
56	11.90	23.80	35.70	47.59	59.50	71.40	83.29	95.20
58	12.32	24.65	36.97	49.30	61.63	73.95	86.27	98.59
60	12.75	25.50	38.25	51.00	63.75	76.50	89.25	102.00

WEIGHT OF STEEL PLATE.

Pounds per Lineal Foot.

THICKNESS IN INCHES.								Width in Inches.
$\frac{9}{16}$	5/8	$\frac{11}{16}$	3/4	$\frac{13}{16}$	7/8	$\frac{15}{16}$	1	
22.95	25.50	28.05	30.60	33.15	35.70	38.25	40.80	12
24.87	27.62	30.38	33.15	35.91	38.68	41.44	44.20	13
26.77	29.75	32.72	35.70	38.68	41.65	44.62	47.60	14
28.69	31.87	35.07	38.25	41.44	44.62	47.82	51.00	15
30.60	34.00	37.40	40.80	44.20	47.60	51.00	54.40	16
32.52	36.13	39.74	43.35	46.97	50.59	54.19	57.80	17
34.42	38.25	42.07	45.90	49.72	53.55	57.37	61.20	18
36.34	40.37	44.41	48.45	52.48	56.52	60.56	64.60	19
38.25	42.50	46.75	51.00	55.25	59.50	63.75	68.00	20
40.17	44.62	49.09	53.55	58.02	62.47	66.94	71.40	21
42.07	46.75	51.43	56.10	60.77	65.45	70.12	74.80	22
43.99	48.88	53.76	58.65	63.55	68.43	73.32	78.20	23
45.90	51.00	56.10	61.20	66.30	71.40	76.50	81.60	24
47.81	53.12	58.43	63.75	69.05	74.37	79.68	85.00	25
49.72	55.25	60.77	66.30	71.83	77.35	82.87	88.40	26
51.64	57.37	63.12	68.85	74.59	80.32	86.07	91.80	27
53.55	59.50	65.45	71.40	77.36	83.29	89.25	95.20	28
55.47	61.63	67.79	73.95	80.12	86.28	92.44	98.60	29
57.37	63.75	70.12	76.50	82.87	89.25	95.62	102.00	30
61.20	68.00	74.80	81.60	88.40	95.20	102.00	108.80	32
65.02	72.25	79.47	86.70	93.92	101.14	108.38	115.60	34
68.85	76.50	84.15	91.80	99.45	107.10	114.75	122.40	36
72.67	80.75	88.83	96.90	104.98	113.02	121.13	129.20	38
76.50	85.00	93.49	102.00	110.50	119.03	127.50	136.00	40
80.32	89.25	98.17	107.10	116.03	124.95	133.88	142.80	42
84.15	93.50	102.85	112.20	121.55	130.90	140.25	149.60	44
87.97	97.75	107.53	117.30	127.08	136.85	146.63	156.40	46
91.80	102.00	112.20	122.40	132.60	142.80	153.00	163.20	48
95.63	106.25	116.88	127.50	138.13	148.75	159.38	170.00	50
99.45	110.47	121.55	132.60	143.65	154.70	165.75	176.80	52
103.33	114.75	126.23	137.70	149.18	160.65	172.13	183.60	54
107.10	119.00	130.90	142.80	154.70	166.60	178.50	190.40	56
110.93	123.25	135.58	147.90	160.23	172.55	184.88	197.20	58
114.75	127.50	140.25	153.00	165.75	178.50	191.25	204.00	60

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	1/16″ Thick. Lbs. per Foot.	1/16″ Thick. Area in Sq. Ins.	1/8″ Thick. Lbs. per Foot.	1/8″ Thick. Area in Sq. Ins.	3/16″ Thick. Lbs. per Foot.	3/16″ Thick. Area in Sq. Ins.	Width in Inches.
1	**.213**	.063	**.425**	.125	**.637**	.188	1
1⅛	**.239**	.070	**.478**	.141	**.717**	.211	1⅛
1¼	**.266**	.078	**.531**	.156	**.797**	.234	1¼
1⅜	**.292**	.086	**.584**	.172	**.877**	.258	1⅜
1½	**.319**	.094	**.638**	.188	**.956**	.281	1½
1⅝	**.345**	.102	**.691**	.203	**1.04**	.305	1⅝
1¾	**.372**	.109	**.744**	.219	**1.12**	.328	1¾
1⅞	**.399**	.117	**.797**	.234	**1.20**	.352	1⅞
2	**.425**	.125	**.850**	.250	**1.28**	.375	2
2⅛	**.452**	.133	**.903**	.266	**1.35**	.398	2⅛
2¼	**.478**	.141	**.956**	.281	**1.43**	.422	2¼
2⅜	**.505**	.148	**1.01**	.297	**1.51**	.445	2⅜
2½	**.531**	.156	**1.06**	.313	**1.59**	.469	2½
2⅝	**.558**	.164	**1.11**	.328	**1.67**	.492	2⅝
2¾	**.584**	.172	**1.17**	.344	**1.75**	.516	2¾
2⅞	**.611**	.180	**1.22**	.359	**1.83**	.539	2⅞
3	**.638**	.188	**1.28**	.375	**1.91**	.563	3
3¼	**.691**	.203	**1.38**	.406	**2.07**	.609	3¼
3½	**.744**	.219	**1.49**	.438	**2.23**	.656	3½
3¾	**.797**	.234	**1.59**	.469	**2.39**	.703	3¾
4	**.850**	.250	**1.70**	.500	**2.55**	.750	4
4¼	**.903**	.266	**1.81**	.531	**2.71**	.797	4¼
4½	**.956**	.281	**1.91**	.563	**2.87**	.844	4½
4¾	**1.01**	.297	**2.02**	.594	**3.03**	.891	4¾
5	**1.06**	.313	**2.12**	.625	**3.19**	.938	5
5¼	**1.12**	.328	**2.23**	.656	**3.35**	.984	5¼
5½	**1.17**	.344	**2.34**	.688	**3.51**	1.03	5½
5¾	**1.22**	.359	**2.44**	.719	**3.67**	1.08	5¾
6	**1.28**	.375	**2.55**	.750	**3.83**	1.13	6
6½	**1.38**	.406	**2.76**	.813	**4.14**	1.22	6½
7	**1.49**	.438	**2.98**	.875	**4.46**	1.31	7
8	**1.70**	.500	**3.40**	1.00	**5.10**	1.50	8
9	**1.91**	.563	**3.83**	1.13	**5.74**	1.69	9
10	**2.13**	.625	**4.25**	1.25	**6.38**	1.88	10
11	**2.34**	.688	**4.67**	1.38	**7.01**	2.06	11
12	**2.55**	.750	**5.10**	1.50	**7.65**	2.25	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	*¼" Thick.*		*5/16" Thick.*		*⅜" Thick.*		*Width in Inches.*
	Lbs. per Foot.	*Area in Sq. Ins.*	*Lbs. per Foot.*	*Area in Sq. Ins.*	*Lbs. per Foot.*	*Area in Sq. Ins.*	
1	**.850**	.250	**1.06**	.313	**1.28**	.375	1
1⅛	**.956**	.281	**1.20**	.352	**1.43**	.422	1⅛
1¼	**1.06**	.313	**1.33**	.391	**1.59**	.469	1¼
1⅜	**1.17**	.344	**1.46**	.430	**1.75**	.516	1⅜
1½	**1.28**	.375	**1.59**	.469	**1.91**	.563	1½
1⅝	**1.38**	.406	**1.73**	.508	**2.07**	.609	1⅝
1¾	**1.49**	.438	**1.86**	.547	**2.23**	.656	1¾
1⅞	**1.59**	.469	**1.99**	.586	**2.39**	.703	1⅞
2	**1.70**	.500	**2.12**	.625	**2.55**	.750	2
2⅛	**1.81**	.531	**2.26**	.664	**2.71**	.797	2⅛
2¼	**1.91**	.563	**2.39**	.703	**2.87**	.844	2¼
2⅜	**2.02**	.594	**2.52**	.742	**3.03**	.891	2⅜
2½	**2.12**	.625	**2.66**	.781	**3.19**	.938	2½
2⅝	**2.23**	.656	**2.79**	.820	**3.35**	.984	2⅝
2¾	**2.34**	.688	**2.92**	.859	**3.51**	1.03	2¾
2⅞	**2.44**	.719	**3.06**	.898	**3.67**	1.08	2⅞
3	**2.55**	.750	**3.19**	.938	**3.83**	1.13	3
3¼	**2.76**	.813	**3.45**	1.02	**4.14**	1.22	3¼
3½	**2.98**	.875	**3.72**	1.09	**4.46**	1.31	3½
3¾	**3.19**	.938	**3.99**	1.17	**4.78**	1.41	3¾
4	**3.40**	1.00	**4.25**	1.25	**5.10**	1.50	4
4¼	**3.61**	1.06	**4.52**	1.33	**5.42**	1.59	4¼
4½	**3.83**	1.13	**4.78**	1.41	**5.74**	1.69	4½
4¾	**4.04**	1.19	**5.05**	1.48	**6.06**	1.78	4¾
5	**4.25**	1.25	**5.31**	1.56	**6.38**	1.88	5
5¼	**4.46**	1.31	**5.58**	1.64	**6.69**	1.97	5¼
5½	**4.67**	1.38	**5.84**	1.72	**7.01**	2.06	5½
5¾	**4.89**	1.44	**6.11**	1.80	**7.33**	2.16	5¾
6	**5.10**	1.50	**6.38**	1.88	**7.65**	2.25	6
6½	**5.53**	1.63	**6.91**	2.03	**8.29**	2.44	6½
7	**5.95**	1.75	**7.44**	2.19	**8.93**	2.63	7
8	**6.80**	2.00	**8.50**	2.50	**10.20**	3.00	8
9	**7.65**	2.25	**9.56**	2.81	**11.48**	3.38	9
10	**8.50**	2.50	**10.63**	3.13	**12.75**	3.75	10
11	**9.35**	2.75	**11.69**	3.44	**14.03**	4.13	11
12	**10.20**	3.00	**12.75**	3.75	**15.30**	4.50	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	*$\frac{7}{16}$" Thick.*		*$\frac{1}{2}$" Thick.*		*$\frac{9}{16}$" Thick.*		*Width in Inches.*
	Lbs. per Foot.	*Area in Sq. Ins.*	*Lbs. per Foot.*	*Area in Sq. Ins.*	*Lbs. per Foot.*	*Area in Sq. Ins.*	
1	**1.49**	.438	**1.70**	.500	**1.92**	.563	1
$1\frac{1}{8}$	**1.67**	.492	**1.91**	.563	**2.15**	.633	$1\frac{1}{8}$
$1\frac{1}{4}$	**1.86**	.547	**2.12**	.625	**2.39**	.703	$1\frac{1}{4}$
$1\frac{3}{8}$	**2.05**	.602	**2.34**	.688	**2.63**	.773	$1\frac{3}{8}$
$1\frac{1}{2}$	**2.23**	.656	**2.55**	.750	**2.87**	.844	$1\frac{1}{2}$
$1\frac{5}{8}$	**2.42**	.711	**2.76**	.813	**3.11**	.914	$1\frac{5}{8}$
$1\frac{3}{4}$	**2.60**	.766	**2.98**	.875	**3.35**	.984	$1\frac{3}{4}$
$1\frac{7}{8}$	**2.79**	.820	**3.19**	.938	**3.57**	1.05	$1\frac{7}{8}$
2	**2.98**	.875	**3.40**	1.00	**3.83**	1.13	2
$2\frac{1}{8}$	**3.16**	.930	**3.61**	1.06	**4.08**	1.20	$2\frac{1}{8}$
$2\frac{1}{4}$	**3.35**	.984	**3.83**	1.13	**4.30**	1.27	$2\frac{1}{4}$
$2\frac{3}{8}$	**3.53**	1.04	**4.04**	1.19	**4.55**	1.34	$2\frac{3}{8}$
$2\frac{1}{2}$	**3.72**	1.09	**4.25**	1.25	**4.78**	1.41	$2\frac{1}{2}$
$2\frac{5}{8}$	**3.91**	1.15	**4.46**	1.31	**5.02**	1.48	$2\frac{5}{8}$
$2\frac{3}{4}$	**4.09**	1.20	**4.68**	1.38	**5.26**	1.55	$2\frac{3}{4}$
$2\frac{7}{8}$	**4.28**	1.26	**4.89**	1.44	**5.50**	1.62	$2\frac{7}{8}$
3	**4.46**	1.31	**5.10**	1.50	**5.74**	1.69	3
$3\frac{1}{4}$	**4.83**	1.42	**5.53**	1.63	**6.22**	1.83	$3\frac{1}{4}$
$3\frac{1}{2}$	**5.21**	1.53	**5.95**	1.75	**6.70**	1.97	$3\frac{1}{2}$
$3\frac{3}{4}$	**5.58**	1.64	**6.38**	1.88	**7.17**	2.11	$3\frac{3}{4}$
4	**5.95**	1.75	**6.80**	2.00	**7.65**	2.25	4
$4\frac{1}{4}$	**6.32**	1.86	**7.23**	2.13	**8.13**	2.39	$4\frac{1}{4}$
$4\frac{1}{2}$	**6.69**	1.97	**7.65**	2.25	**8.61**	2.53	$4\frac{1}{2}$
$4\frac{3}{4}$	**7.07**	2.08	**8.08**	2.38	**9.09**	2.67	$4\frac{3}{4}$
5	**7.44**	2.19	**8.50**	2.50	**9.57**	2.81	5
$5\frac{1}{4}$	**7.81**	2.30	**8.93**	2.63	**10.04**	2.95	$5\frac{1}{4}$
$5\frac{1}{2}$	**8.18**	2.41	**9.35**	2.75	**10.52**	3.09	$5\frac{1}{2}$
$5\frac{3}{4}$	**8.55**	2.52	**9.78**	2.88	**11.00**	3.23	$5\frac{3}{4}$
6	**8.93**	2.63	**10.20**	3.00	**11.48**	3.38	6
$6\frac{1}{2}$	**9.67**	2.84	**11.05**	3.25	**12.43**	3.66	$6\frac{1}{2}$
7	**10.41**	3.06	**11.90**	3.50	**13.39**	3.94	7
8	**11.90**	3.50	**13.60**	4.00	**15.30**	4.50	8
9	**13.39**	3.94	**15.30**	4.50	**17.22**	5.06	9
10	**14.88**	4.38	**17.00**	5.00	**19.14**	5.63	10
11	**16.36**	4.81	**18.70**	5.50	**21.05**	6.19	11
12	**17.85**	5.25	**20.40**	6.00	**22.95**	6.75	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	5/8″ Thick. Lbs. per Foot.	5/8″ Thick. Area in Sq. Ins.	11/16″ Thick. Lbs. per Foot.	11/16″ Thick. Area in Sq. Ins.	3/4″ Thick. Lbs. per Foot.	3/4″ Thick. Area in Sq. Ins.	Width in Inches.
1	**2.12**	.625	**2.34**	.688	**2.55**	.750	1
1 1/8	**2.39**	.703	**2.63**	.773	**2.87**	.844	1 1/8
1 1/4	**2.66**	.781	**2.92**	.859	**3.19**	.938	1 1/4
1 3/8	**2.92**	.859	**3.21**	.945	**3.51**	1.03	1 3/8
1 1/2	**3.19**	.938	**3.51**	1.03	**3.83**	1.13	1 1/2
1 5/8	**3.45**	1.02	**3.80**	1.12	**4.14**	1.22	1 5/8
1 3/4	**3.72**	1.09	**4.09**	1.20	**4.47**	1.31	1 3/4
1 7/8	**3.99**	1.17	**4.39**	1.29	**4.78**	1.41	1 7/8
2	**4.25**	1.25	**4.67**	1.38	**5.10**	1.50	2
2 1/8	**4.52**	1.33	**4.97**	1.46	**5.42**	1.59	2 1/8
2 1/4	**4.78**	1.41	**5.26**	1.55	**5.74**	1.69	2 1/4
2 3/8	**5.05**	1.48	**5.55**	1.63	**6.06**	1.78	2 3/8
2 1/2	**5.31**	1.56	**5.84**	1.72	**6.38**	1.88	2 1/2
2 5/8	**5.58**	1.64	**6.13**	1.80	**6.69**	1.97	2 5/8
2 3/4	**5.84**	1.72	**6.43**	1.89	**7.02**	2.06	2 3/4
2 7/8	**6.11**	1.80	**6.72**	1.98	**7.33**	2.16	2 7/8
3	**6.38**	1.88	**7.02**	2.06	**7.65**	2.25	3
3 1/4	**6.91**	2.03	**7.60**	2.23	**8.29**	2.44	3 1/4
3 1/2	**7.44**	2.19	**8.18**	2.41	**8.93**	2.63	3 1/2
3 3/4	**7.97**	2.34	**8.76**	2.58	**9.57**	2.81	3 3/4
4	**8.50**	2.50	**9.35**	2.75	**10.20**	3.00	4
4 1/4	**9.03**	2.66	**9.93**	2.92	**10.84**	3.19	4 1/4
4 1/2	**9.56**	2.81	**10.52**	3.09	**11.48**	3.38	4 1/2
4 3/4	**10.09**	2.97	**11.11**	3.27	**12.12**	3.56	4 3/4
5	**10.63**	3.13	**11.69**	3.44	**12.75**	3.75	5
5 1/4	**11.16**	3.28	**12.27**	3.61	**13.39**	3.94	5 1/4
5 1/2	**11.69**	3.44	**12.85**	3.78	**14.03**	4.13	5 1/2
5 3/4	**12.22**	3.59	**13.44**	3.95	**14.67**	4.31	5 3/4
6	**12.75**	3.75	**14.03**	4.13	**15.30**	4.50	6
6 1/2	**13.81**	4.06	**15.20**	4.47	**16.58**	4.88	6 1/2
7	**14.87**	4.38	**16.36**	4.81	**17.85**	5.25	7
8	**17.00**	5.00	**18.70**	5.50	**20.40**	6.00	8
9	**19.13**	5.63	**21.04**	6.19	**22.95**	6.75	9
10	**21.25**	6.25	**23.38**	6.88	**25.50**	7.50	10
11	**23.38**	6.88	**25.71**	7.56	**28.05**	8.25	11
12	**25.50**	7.50	**28.05**	8.25	**30.60**	9.00	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	*$\frac{13}{16}''$ Thick.* Lbs. per Foot.	*$\frac{13}{16}''$ Thick.* Area in Sq. Ins.	*$\frac{7}{8}''$ Thick.* Lbs. per Foot.	*$\frac{7}{8}''$ Thick.* Area in Sq. Ins.	*$\frac{15}{16}''$ Thick.* Lbs. per Foot.	*$\frac{15}{16}''$ Thick.* Area in Sq. Ins.	*Width in Inches.*
1	**2.76**	.813	**2.98**	.875	**3.19**	.938	1
1⅛	**3.11**	.914	**3.35**	.984	**3.60**	1.06	1⅛
1¼	**3.45**	1.02	**3.72**	1.09	**3.99**	1.17	1¼
1⅜	**3.80**	1.12	**4.09**	1.20	**4.39**	1.29	1⅜
1½	**4.14**	1.22	**4.46**	1.31	**4.78**	1.41	1½
1⅝	**4.49**	1.32	**4.83**	1.42	**5.18**	1.52	1⅝
1¾	**4.83**	1.42	**5.21**	1.53	**5.58**	1.64	1¾
1⅞	**5.18**	1.52	**5.58**	1.64	**5.98**	1.76	1⅞
2	**5.53**	1.63	**5.95**	1.75	**6.38**	1.88	2
2⅛	**5.88**	1.73	**6.32**	1.86	**6.77**	1.99	2⅛
2¼	**6.21**	1.83	**6.69**	1.97	**7.17**	2.11	2¼
2⅜	**6.56**	1.93	**7.07**	2.08	**7.57**	2.23	2⅜
2½	**6.91**	2.03	**7.44**	2.19	**7.97**	2.34	2½
2⅝	**7.25**	2.13	**7.81**	2.30	**8.36**	2.46	2⅝
2¾	**7.60**	2.23	**8.18**	2.41	**8.77**	2.58	2¾
2⅞	**7.95**	2.34	**8.55**	2.52	**9.17**	2.70	2⅞
3	**8.29**	2.44	**8.93**	2.63	**9.57**	2.81	3
3¼	**8.98**	2.64	**9.67**	2.84	**10.36**	3.05	3¼
3½	**9.67**	2.84	**10.41**	3.06	**11.16**	3.28	3½
3¾	**10.36**	3.05	**11.16**	3.28	**11.95**	3.52	3¾
4	**11.05**	3.25	**11.90**	3.50	**12.75**	3.75	4
4¼	**11.74**	3.45	**12.64**	3.72	**13.55**	3.98	4¼
4½	**12.43**	3.66	**13.39**	3.94	**14.34**	4.22	4½
4¾	**13.12**	3.86	**14.13**	4.16	**15.14**	4.45	4¾
5	**13.81**	4.06	**14.87**	4.38	**15.94**	4.69	5
5¼	**14.50**	4.27	**15.62**	4.59	**16.74**	4.92	5¼
5½	**15.19**	4.47	**16.36**	4.81	**17.53**	5.16	5½
5¾	**15.88**	4.67	**17.11**	5.03	**18.33**	5.39	5¾
6	**16.58**	4.88	**17.85**	5.25	**19.13**	5.63	6
6½	**17.95**	5.28	**19.34**	5.69	**20.72**	6.09	6½
7	**19.34**	5.69	**20.83**	6.13	**22.32**	6.56	7
8	**22.10**	6.50	**23.80**	7.00	**25.50**	7.50	8
9	**24.86**	7.31	**26.78**	7.88	**28.69**	8.44	9
10	**27.62**	8.13	**29.75**	8.75	**31.88**	9.38	10
11	**30.39**	8.94	**32.72**	9.63	**35.06**	10.31	11
12	**33.15**	9.75	**35.70**	10.50	**38.25**	11.25	12

FLAT BARS.
SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	1″ Thick.		$1\frac{1}{16}$″ Thick.		$1\frac{3}{16}$″ Thick.		Width in Inches.
	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	
1	**3.40**	1.00	**3.61**	1.06	**4.04**	1.19	1
1⅛	**3.83**	1.13	**4.08**	1.20	**4.56**	1.34	1⅛
1¼	**4.25**	1.25	**4.52**	1.33	**5.05**	1.48	1¼
1⅜	**4.67**	1.38	**4.97**	1.46	**5.55**	1.63	1⅜
1½	**5.10**	1.50	**5.42**	1.59	**6.06**	1.78	1½
1⅝	**5.53**	1.63	**5.87**	1.73	**6.56**	1.93	1⅝
1¾	**5.95**	1.75	**6.32**	1.86	**7.07**	2.08	1¾
1⅞	**6.38**	1.88	**6.77**	1.99	**7.57**	2.23	1⅞
2	**6.80**	2.00	**7.22**	2.13	**8.08**	2.38	2
2⅛	**7.23**	2.13	**7.68**	2.26	**8.58**	2.52	2⅛
2¼	**7.65**	2.25	**8.13**	2.39	**9.09**	2.67	2¼
2⅜	**8.08**	2.38	**8.58**	2.52	**9.59**	2.82	2⅜
2½	**8.50**	2.50	**9.03**	2.66	**10.10**	2.97	2½
2⅝	**8.93**	2.63	**9.49**	2.79	**10.60**	3.12	2⅝
2¾	**9.35**	2.75	**9.93**	2.92	**11.11**	3.27	2¾
2⅞	**9.77**	2.88	**10.38**	3.05	**11.61**	3.41	2⅞
3	**10.20**	3.00	**10.84**	3.19	**12.12**	3.56	3
3¼	**11.05**	3.25	**11.74**	3.45	**13.12**	3.86	3¼
3½	**11.90**	3.50	**12.65**	3.72	**14.13**	4.16	3½
3¾	**12.75**	3.75	**13.55**	3.98	**15.14**	4.45	3¾
4	**13.60**	4.00	**14.45**	4.25	**16.15**	4.75	4
4¼	**14.45**	4.25	**15.35**	4.52	**17.16**	5.05	4¼
4½	**15.30**	4.50	**16.26**	4.78	**18.17**	5.34	4½
4¾	**16.15**	4.75	**17.16**	5.05	**19.18**	5.64	4¾
5	**17.00**	5.00	**18.06**	5.31	**20.19**	5.94	5
5¼	**17.85**	5.25	**18.96**	5.58	**21.20**	6.23	5¼
5½	**18.70**	5.50	**19.87**	5.84	**22.21**	6.53	5½
5¾	**19.55**	5.75	**20.77**	6.11	**23.22**	6.83	5¾
6	**20.40**	6.00	**21.68**	6.38	**24.23**	7.13	6
6½	**22.10**	6.50	**23.48**	6.91	**26.24**	7.72	6½
7	**23.80**	7.00	**25.29**	7.44	**28.26**	8.31	7
8	**27.20**	8.00	**28.90**	8.50	**32.30**	9.50	8
9	**30.60**	9.00	**32.52**	9.56	**36.34**	10.69	9
10	**34.00**	10.00	**36.13**	10.63	**40.38**	11.88	10
11	**37.40**	11.00	**39.74**	11.69	**44.41**	13.06	11
12	**40.80**	12.00	**43.35**	12.75	**48.45**	14.25	12

ROUND AND SQUARE BARS.

Sectional area in inches × 3.4 = weight per lineal foot in pounds.

Thickness or Diameter in Inches.	Weight per Lineal Foot in Pounds. Round ●	Square ■	Area of ◍ in Sq. Ins.	Thickness or Diameter in Inches.	Weight per Lineal Foot in Pounds. Round ●	Square ■	Area of ◍ in Sq. Ins.
0				2	10.68	13.60	3.1416
$\frac{1}{16}$	.010	.013	.0031	$\frac{1}{16}$	11.36	14.46	3.3410
⅛	.042	.053	.0123	⅛	12.06	15.35	3.5466
$\frac{3}{16}$	.094	.119	.0276	$\frac{3}{16}$	12.78	16.27	3.7583
¼	.167	.212	.0491	¼	13.51	17.22	3.9761
$\frac{5}{16}$	.261	.332	.0767	$\frac{5}{16}$	14.28	18.19	4.2000
⅜	.375	.478	.1104	⅜	15.06	19.18	4.4301
$\frac{7}{16}$	.511	.651	.1503	$\frac{7}{16}$	15.86	20.20	4.6664
½	.667	.850	.1963	½	16.69	21.25	4.9087
$\frac{9}{16}$	.844	1.076	.2485	$\frac{9}{16}$	17.53	22.33	5.1572
⅝	1.043	1.328	.3068	⅝	18.40	23.43	5.4119
$\frac{11}{16}$	1.261	1.607	.3712	$\frac{11}{16}$	19.29	24.56	5.6727
¾	1.502	1.912	.4418	¾	20.20	25.71	5.9396
$\frac{13}{16}$	1.762	2.245	.5185	$\frac{13}{16}$	21.12	26.90	6.2126
⅞	2.044	2.603	.6013	⅞	22.07	28.10	6.4918
$\frac{15}{16}$	2.347	2.989	.6903	$\frac{15}{16}$	23.04	29.33	6.7771
1	2.670	3.400	.7854	3	24.01	30.60	7.0686
$\frac{1}{16}$	3.014	3.838	.8866	$\frac{1}{16}$	25.04	31.88	7.3662
⅛	3.379	4.303	.9940	⅛	26.08	33.20	7.6699
$\frac{3}{16}$	3.766	4.795	1.1075	$\frac{3}{16}$	27.13	34.55	7.9798
¼	4.173	5.312	1.2272	¼	28.20	35.91	8.2958
$\frac{5}{16}$	4.600	5.857	1.3530	$\frac{5}{16}$	29.30	37.31	8.6179
⅜	5.049	6.428	1.4849	⅜	30.41	38.73	8.9462
$\frac{7}{16}$	5.518	7.026	1.6230	$\frac{7}{16}$	31.55	40.18	9.2806
½	6.008	7.650	1.7671	½	32.71	41.65	9.6211
$\frac{9}{16}$	6.520	8.301	1.9175	$\frac{9}{16}$	33.89	43.15	9.9678
⅝	7.051	8.978	2.0739	⅝	35.09	44.68	10.321
$\frac{11}{16}$	7.604	9.682	2.2365	$\frac{11}{16}$	36.31	46.24	10.680
¾	8.178	10.41	2.4053	¾	37.55	47.82	11.045
$\frac{13}{16}$	8.773	11.17	2.5802	$\frac{13}{16}$	38.81	49.42	11.416
⅞	9.388	11.95	2.7612	⅞	40.10	51.05	11.793
$\frac{15}{16}$	10.024	12.76	2.9483	$\frac{15}{16}$	41.40	52.71	12.177

ROUND AND SQUARE BARS.

Sectional area in inches × 3.4 = weight per lineal foot in pounds.

Thickness or Diameter in Inches.	Weight per Lineal Foot in Pounds. Round ●	Square ■	Area of ◍ in Sq. Ins.	Thickness or Diameter in Inches.	Weight per Lineal Foot in Pounds. Round ●	Square ■	Area of ◍ in Sq. Ins.
4	42.72	54.39	12.566	6	96.1	122.4	28.274
1/16	44.07	56.11	12.962	1/16	98.1	125.0	28.866
1/8	45.44	57.85	13.364	1/8	100.2	127.6	29.465
3/16	46.83	59.62	13.772	3/16	102.2	130.2	30.069
1/4	48.23	61.41	14.186	1/4	104.3	132.8	30.680
5/16	49.66	63.23	14.607	5/16	106.4	135.5	31.296
3/8	51.11	65.08	15.033	3/8	108.5	138.2	31.919
7/16	52.58	66.95	15.466	7/16	110.7	140.9	32.548
1/2	54.07	68.85	15.904	1/2	112.8	143.6	33.183
9/16	55.59	70.78	16.349	9/16	115.0	146.5	33.824
5/8	57.12	72.72	16.800	5/8	117.2	149.2	34.472
11/16	58.67	74.70	17.257	11/16	119.4	152.1	35.125
3/4	60.25	76.71	17.721	3/4	121.7	154.9	35.785
13/16	61.84	78.74	18.190	13/16	123.9	157.8	36.450
7/8	63.46	80.80	18.665	7/8	126.2	160.7	37.122
15/16	65.10	82.89	19.147	15/16	128.5	163.6	37.800
5	66.76	85.00	19.635	7	130.9	166.6	38.485
1/16	68.44	87.14	20.129	1/16	133.2	169.6	39.175
1/8	70.13	89.30	20.629	1/8	135.6	172.6	39.871
3/16	71.86	91.49	21.135	3/16	137.9	175.6	40.574
1/4	73.60	93.72	21.648	1/4	140.4	178.7	41.282
5/16	75.37	95.96	22.166	5/16	142.8	181.8	41.997
3/8	77.15	98.22	22.691	3/8	145.2	184.9	42.718
7/16	78.95	100.5	23.221	7/16	147.7	188.1	43.445
1/2	80.77	102.8	23.758	1/2	150.2	191.3	44.179
9/16	82.62	105.2	24.301	9/16	152.7	194.4	44.918
5/8	84.48	107.6	24.850	5/8	155.2	197.7	45.664
11/16	86.38	110.0	25.406	11/16	157.8	200.9	46.415
3/4	88.29	112.4	25.967	3/4	160.3	204.2	47.173
13/16	90.22	114.9	26.535	13/16	163.0	207.6	47.937
7/8	92.16	117.4	27.109	7/8	165.6	210.8	48.707
15/16	94.14	119.9	27.688	15/16	168.2	214.2	49.483

AREAS OF CIRCLES.

Diameters increasing by eighths.

No.	No. + 0.	No. + ⅛	No. + ¼	No. + ⅜	No. + ½	No. + ⅝	No. + ¾	No. + ⅞
0	0.00000	0.01227	0.04909	0.11045	0.19635	0.30680	0.44179	0.60132
1	0.78540	0.99402	1.2272	1.4849	1.7671	2.0739	2.4053	2.7612
2	3.1416	3.5466	3.9761	4.4301	4.9087	5.4119	5.9396	6.4918
3	7.0686	7.6699	8.2958	8.9462	9.6211	10.321	11.045	11.793
4	12.566	13.364	14.186	15.033	15.904	16.800	17.721	18.665
5	19.635	20.629	21.648	22.691	23.758	24.850	25.967	27.109
6	28.274	29.465	30.680	31.919	33.183	34.472	35.785	37.122
7	38.485	39.871	41.282	42.718	44.179	45.664	47.173	48.707
8	50.265	51.849	53.456	55.088	56.745	58.426	60.132	61.862
9	63.617	65.397	67.201	69.029	70.882	72.760	74.662	76.589
10	78.540	80.516	82.516	84.541	86.590	88.664	90.763	92.886
11	95.033	97.205	99.402	101.62	103.87	106.14	108.43	110.75
12	113.10	115.47	117.86	120.28	122.72	125.19	127.68	130.19
13	132.73	135.30	137.89	140.50	143.14	145.80	148.49	151.20
14	153.94	156.70	159.48	162.30	165.13	167.99	170.87	173.78
15	176.71	179.67	182.65	185.66	188.69	191.75	194.83	197.93
16	201.06	204.22	207.39	210.60	213.82	217.08	220.35	223.65
17	226.98	230.33	233.71	237.10	240.53	243.98	247.45	250.95
18	254.47	258.02	261.59	265.18	268.80	272.45	276.12	279.81
19	283.53	287.27	291.04	294.83	298.65	302.49	306.35	310.24
20	314.16	318.10	322.06	326.05	330.06	334.10	338.16	342.25
21	346.36	350.50	354.66	358.84	363.05	367.28	371.54	375.83
22	380.13	384.46	388.82	393.20	397.61	402.04	406.49	410.97
23	415.48	420.00	424.56	429.13	433.74	438.36	443.01	447.69
24	452.39	457.11	461.86	466.64	471.44	476.26	481.11	485.98
25	490.87	495.79	500.74	505.71	510.71	515.72	520.77	525.84
26	530.93	536.05	541.19	546.35	551.55	556.76	562.00	567.27
27	572.56	577.87	583.21	588.57	593.96	599.37	604.81	610.27
28	615.75	621.26	626.80	632.36	637.94	643.55	649.18	654.84
29	660.52	666.23	671.96	677.71	683.49	689.30	695.13	700.98
30	706.86	712.76	718.69	724.64	730.62	736.62	742.64	748.69
31	754.77	760.87	766.99	773.14	779.31	785.51	791.73	797.98
32	804.25	810.54	816.86	823.21	829.58	835.97	842.39	848.83
33	855.30	861.79	868.31	874.85	881.41	888.00	894.62	901.26
34	907.92	914.61	921.32	928.06	934.82	941.61	948.42	955.25
35	962.11	969.00	975.91	982.84	989.80	996.78	1003.8	1010.8
36	1017.9	1025.0	1032.1	1039.2	1046.3	1053.5	1060.7	1068.0
37	1075.2	1082.5	1089.8	1097.1	1104.5	1111.8	1119.2	1126.7
38	1134.1	1141.6	1149.1	1156.6	1164.2	1171.7	1179.3	1186.9
39	1194.6	1202.3	1210.0	1217.7	1225.4	1233.2	1241.0	1248.8
40	1256.6	1264.5	1272.4	1280.3	1288.2	1296.2	1304.2	1312.2
41	1320.3	1328.3	1336.4	1344.5	1352.7	1360.8	1369.0	1377.2
42	1385.4	1393.7	1402.0	1410.3	1418.6	1427.0	1435.4	1443.8
43	1452.2	1460.7	1469.1	1477.6	1486.2	1494.7	1503.3	1511.9
44	1520.5	1529.2	1537.9	1546.6	1555.3	1564.0	1572.8	1581.6
45	1590.4	1599.3	1608.2	1617.0	1626.0	1684.9	1643.9	1652.9
46	1661.9	1670.9	1680.0	1689.1	1698.2	1707.4	1716.5	1725.7
47	1734.9	1744.2	1753.5	1762.7	1772.1	1781.4	1790.8	1800.1
48	1809.6	1819.0	1828.5	1837.9	1847.5	1857.0	1866.5	1876.1
49	1885.7	1895.4	1905.0	1914.7	1924.4	1934.2	1943.9	1953.7

AREAS OF CIRCLES.

Diameters increasing by eighths.

No.	*No. +0.*	*No.+⅛*	*No.+¼*	*No. +⅜*	*No.+½*	*No. +⅝*	*No. +¾*	*No. +⅞*
50	1963.5	1973.3	1983.2	1993.1	2003.0	2012.9	2022.8	2032.8
51	2042.8	2052.8	2062.9	2073.0	2083.1	2093.2	2103.3	2113.5
52	2123.7	2133.9	2144.2	2154.5	2164.8	2175.1	2185.4	2195.8
53	2206.2	2216.6	2227.0	2237.5	2248.0	2258.5	2269.1	2279.6
54	2290.2	2300.8	2311.5	2322.1	2332.8	2343.5	2354.3	2365.0
55	2375.8	2386.6	2397.5	2408.3	2419.2	2430.1	2441.1	2452.0
56	2463.0	2474.0	2485.0	2496.1	2507.2	2518.3	2529.4	2540.6
57	2551.8	2563.0	2574.2	2585.4	2596.7	2608.0	2619.4	2630.7
58	2642.1	2653.5	2664.9	2676.4	2687.8	2699.3	2710.9	2722.4
59	2734.0	2745.6	2757.2	2768.8	2780.5	2792.2	2803.9	2815.7
60	2827.4	2839.2	2851.0	2862.9	2874.8	2886.6	2898.6	2910.5
61	2922.5	2934.5	2946.5	2958.5	2970.6	2982.7	2994.8	3006.9
62	3019.1	3031.3	3043.5	3055.7	3068.0	3080.3	3092.6	3104.9
63	3117.2	3129.6	3142.0	3154.5	3166.9	3179.4	3191.9	3204.4
64	3217.0	3229.6	3242.2	3254.8	3267.5	3280.1	3292.8	3305.6
65	3318.3	3331.1	3343.9	3356.7	3369.6	3382.4	3395.3	3408.2
66	3421.2	3434.3	3447.2	3460.2	3473.2	3486.3	3499.4	3512.5
67	3525.7	3538.8	3552.0	3565.2	3578.5	3591.7	3605.0	3618.3
68	3631.7	3645.0	3658.4	3671.8	3685.3	3698.7	3712.2	3725.7
69	3739.3	3752.8	3766.4	3780.0	3793.7	3807.3	3821.0	3834.7
70	3848.5	3862.2	3876.0	3889.8	3903.6	3917.5	3931.4	3945.3
71	3959.2	3973.1	3987.1	4001.1	4015.2	4029.2	4043.3	4057.4
72	4071.5	4085.7	4099.8	4114.0	4128.2	4142.5	4156.8	4171.1
73	4185.4	4199.7	4214.1	4228.5	4242.9	4257.4	4271.8	4286.3
74	4300.8	4315.4	4329.9	4344.5	4359.2	4373.8	4388.5	4403.1
75	4417.9	4432.6	4447.4	4462.2	4477.0	4491.8	4506.7	4521.5
76	4536.5	4551.4	4566.4	4581.3	4596.3	4611.4	4626.4	4641.5
77	4656.6	4671.8	4686.9	4702.1	4717.3	4732.5	4747.8	4763.1
78	4778.4	4793.7	4809.0	4824.4	4839.8	4855.2	4870.7	4886.2
79	4901.7	4917.2	4932.7	4948.3	4963.9	4979.5	4995.2	5010.9
80	5026.5	5042.3	5058.0	5073.8	5089.6	5105.4	5121.2	5137.1
81	5153.0	5168.9	5184.9	5200.8	5216.8	5232.8	5248.9	5264.9
82	5281.0	5297.1	5313.3	5329.4	5345.6	5361.8	5378.1	5394.3
83	5410.6	5426.9	5443.3	5459.6	5476.0	5492.4	5508.8	5525.3
84	5541.8	5558.3	5574.8	5591.4	5607.9	5624.5	5641.2	5657.8
85	5674.5	5691.2	5707.9	5724.7	5741.5	5758.3	5775.1	5791.9
86	5808.8	5825.7	5842.6	5859.6	5876.5	5893.5	5910.6	5927.6
87	5944.7	5961.8	5978.9	5996.0	6013.2	6030.4	6047.6	6064.9
88	6082.1	6099.4	6116.7	6134.1	6151.4	6168.8	6186.2	6203.7
89	6221.1	6238.6	6256.1	6273.7	6291.2	6308.8	6326.4	6344.1
90	6361.7	6379.4	6397.1	6414.9	6432.6	6450.4	6468.2	6486.0
91	6503.9	6521.8	6539.7	6557.6	6575.5	6593.5	6611.5	6629.6
92	6647.6	6665.7	6683.8	6701.9	6720.1	6738.2	6756.4	6774.7
93	6792.9	6811.2	6829.5	6847.8	6866.1	6884.5	6902.9	6921.3
94	6939.8	6958.2	6976.7	6995.3	7013.8	7032.4	7051.0	7069.6
95	7088.2	7106.9	7125.6	7144.3	7163.0	7181.8	7200.6	7219.4
96	7238.2	7257.1	7276.0	7294.9	7313.8	7332.8	7351.8	7370.8
97	7389.8	7408.9	7428.0	7447.1	7466.2	7485.3	7504.5	7523.7
98	7543.0	7562.2	7581.5	7600.8	7620.1	7639.5	7658.9	7678.3
99	7697.7	7717.1	7736.6	7756.1	7775.6	7795.2	7814.8	7834.4

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
1	3.142	0.7854	1	1	1.0000	1.0000	0.00000	1000.000
2	6.283	3.1416	4	8	1.4142	1.2599	0.30103	500.000
3	9.425	7.0686	9	27	1.7321	1.4422	0.47712	333.333
4	12.566	12.5664	16	64	2.0000	1.5874	0.60206	250.000
5	15.708	19.6350	25	125	2.2361	1.7100	0.69897	200.000
6	18.850	28.2743	36	216	2.4495	1.8171	0.77815	166.667
7	21.991	38.4845	49	343	2.6458	1.9129	0.84510	142.857
8	25.133	50.2655	64	512	2.8284	2.0000	0.90309	125.000
9	28.274	63.6173	81	729	3.0000	2.0801	0.95424	111.111
10	31.416	78.5398	100	1000	3.1623	2.1544	1.00000	100.000
11	34.558	95.0332	121	1331	3.3166	2.2240	1.04139	90.9091
12	37.699	113.097	144	1728	3.4641	2.2894	1.07918	83.3333
13	40.841	132.732	169	2197	3.6056	2.3513	1.11394	76.9231
14	43.982	153.938	196	2744	3.7417	2.4101	1.14613	71.4286
15	47.124	176.715	225	3375	3.8730	2.4662	1.17609	66.6667
16	50.265	201.062	256	4096	4.0000	2.5198	1.20412	62.5000
17	53.407	226.980	289	4913	4.1231	2.5713	1.23045	58.8235
18	56.549	254.469	324	5832	4.2426	2.6207	1.25527	55.5556
19	59.690	283.529	361	6859	4.3589	2.6684	1.27875	52.6316
20	62.832	314.159	400	8000	4.4721	2.7144	1.30103	50.0000
21	65.973	346.361	441	9261	4.5826	2.7589	1.32222	47.6190
22	69.115	380.133	484	10648	4.6904	2.8020	1.34242	45.4545
23	72.257	415.476	529	12167	4.7958	2.8439	1.36173	43.4783
24	75.398	452.389	576	13824	4.8990	2.8845	1.38021	41.6667
25	78.540	490.874	625	15625	5.0000	2.9240	1.39794	40.0000
26	81.681	530.929	676	17576	5.0990	2.9625	1.41497	38.4615
27	84.823	572.555	729	19683	5.1962	3.0000	1.43136	37.0370
28	87.965	615.752	784	21952	5.2915	3.0366	1.44716	35.7143
29	91.106	660.520	841	24389	5.3852	3.0723	1.46240	34.4828
30	94.248	706.858	900	27000	5.4772	3.1072	1.47712	33.3333
31	97.389	754.768	961	29791	5.5678	3.1414	1.49136	32.2581
32	100.531	804.248	1024	32768	5.6569	3.1748	1.50515	31.2500
33	103.673	855.299	1089	35937	5.7446	3.2075	1.51851	30.3030
34	106.814	907.920	1156	39304	5.8310	3.2396	1.53148	29.4118
35	109.956	962.113	1225	42875	5.9161	3.2711	1.54407	28.5714
36	113.097	1017.88	1296	46656	6.0000	3.3019	1.55630	27.7778
37	116.239	1075.21	1369	50653	6.0828	3.3322	1.56820	27.0270
38	119.381	1134.11	1444	54872	6.1644	3.3620	1.57978	26.3158
39	122.522	1194.59	1521	59319	6.2450	3.3912	1.59106	25.6410
40	125.66	1256.64	1600	64000	6.3246	3.4200	1.60206	25.0000
41	128.81	1320.25	1681	68921	6.4031	3.4482	1.61278	24.3902
42	131.95	1385.44	1764	74088	6.4807	3.4760	1.62325	23.8095
43	135.09	1452.20	1849	79507	6.5574	3.5034	1.63347	23.2558
44	138.23	1520.53	1936	85184	6.6332	3.5303	1.64345	22.7273
45	141.37	1590.43	2025	91125	6.7082	3.5569	1.65321	22.2222
46	144.51	1661.90	2116	97336	6.7823	3.5830	1.66276	21.7391
47	147.65	1734.94	2209	103823	6.8557	3.6088	1.67210	21.2766
48	150.80	1809.56	2304	110592	6.9282	3.6342	1.68124	20.8333
49	153.94	1885.74	2401	117649	7.0000	3.6593	1.69020	20.4082

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
50	157.08	1963.50	2500	125000	7.0711	3.6840	1.69897	20.0000
51	160.22	2042.82	2601	132651	7.1414	3.7084	1.70757	19.6078
52	163.36	2123.72	2704	140608	7.2111	3.7325	1.71600	19.2308
53	166.50	2206.18	2809	148877	7.2801	3.7563	1.72428	18.8679
54	169.65	2290.22	2916	157464	7.3485	3.7798	1.73239	18.5185
55	172.79	2375.83	3025	166375	7.4162	3.8030	1.74036	18.1818
56	175.93	2463.01	3136	175616	7.4833	3.8259	1.74819	17.8571
57	179.07	2551.76	3249	185193	7.5498	3.8485	1.75587	17.5439
58	182.21	2642.08	3364	195112	7.6158	3.8709	1.76343	17.2414
59	185.35	2733.97	3481	205379	7.6811	3.8930	1.77085	16.9492
60	188.50	2827.43	3600	216000	7.7460	3.9149	1.77815	16.6667
61	191.64	2922.47	3721	226981	7.8102	3.9365	1.78533	16.3934
62	194.78	3019.07	3844	238328	7.8740	3.9579	1.79239	16.1290
63	197.92	3117.25	3969	250047	7.9373	3.9791	1.79934	15.8730
64	201.06	3216.99	4096	262144	8.0000	4.0000	1.80618	15.6250
65	204.20	3318.31	4225	274625	8.0623	4.0207	1.81291	15.3846
66	207.35	3421.19	4356	287496	8.1240	4.0412	1.81954	15.1515
67	210.49	3525.65	4489	300763	8.1854	4.0615	1.82607	14.9254
68	213.63	3631.68	4624	314432	8.2462	4.0817	1.83251	14.7059
69	216.77	3739.28	4761	328509	8.3066	4.1016	1.83885	14.4928
70	219.91	3848.45	4900	343000	8.3666	4.1213	1.84510	14.2857
71	223.05	3959.19	5041	357911	8.4261	4.1408	1.85126	14.0845
72	226.19	4071.50	5184	373248	8.4853	4.1602	1.85733	13.8889
73	229.34	4185.39	5329	389017	8.5440	4.1793	1.86332	13.6986
74	232.48	4300.84	5476	405224	8.6023	4.1983	1.86923	13.5135
75	235.62	4417.86	5625	421875	8.6603	4.2172	1.87506	13.3333
76	238.76	4536.46	5776	438976	8.7178	4.2358	1.88081	13.1579
77	241.90	4656.63	5929	456533	8.7750	4.2543	1.88649	12.9870
78	245.04	4778.36	6084	474552	8.8318	4.2727	1.89209	12.8205
79	248.19	4901.67	6241	493039	8.8882	4.2908	1.89763	12.6582
80	251.33	5026.55	6400	512000	8.9443	4.3089	1.90300	12.5000
81	254.47	5153.00	6561	531441	9.0000	4.3267	1.90849	12.3457
82	257.61	5281.02	6724	551368	9.0554	4.3445	1.91381	12.1951
83	260.75	5410.61	6889	571787	9.1104	4.3621	1.91908	12.0482
84	263.89	5541.77	7056	592704	9.1652	4.3795	1.92428	11.9048
85	267.04	5674.50	7225	614125	9.2195	4.3968	1.92942	11.7647
86	270.18	5808.80	7396	636056	9.2736	4.4140	1.93450	11.6279
87	273.32	5944.68	7569	658503	9.3274	4.4310	1.93952	11.4943
88	276.46	6082.12	7744	681472	9.3808	4.4480	1.94448	11.3636
89	279.60	6221.14	7921	704969	9.4340	4.4647	1.94939	11.2360
90	282.74	6361.73	8100	729000	9.4868	4.4814	1.95424	11.1111
91	285.88	6503.88	8281	753571	9.5394	4.4979	1.95904	10.9890
92	289.03	6647.61	8464	778688	9.5917	4.5144	1.96379	10.8696
93	292.17	6792.91	8649	804357	9.6437	4.5307	1.96848	10.7527
94	295.31	6939.78	8836	830584	9.6954	4.5468	1.97313	10.6383
95	298.45	7088.22	9025	857375	9.7468	4.5629	1.97772	10.5263
96	301.59	7238.23	9216	884736	9.7980	4.5789	1.98227	10.4167
97	304.73	7389.81	9409	912673	9.8489	4.5947	1.98677	10.3093
98	307.88	7542.96	9604	941192	9.8995	4.6104	1.99123	10.2041
99	311.02	7697.69	9801	970299	9.9499	4.6261	1.99564	10.1010

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	*No. = Diam.*		*Square.*	*Cube.*	*Square Root.*	*Cube Root.*	*Log.*	*1000 × Recip.*
	Circum.	*Area.*						
100	314.16	7853.98	10000	1000000	10.0000	4.6416	2.00000	10.0000
101	317.30	8011.85	10201	1030301	10.0499	4.6570	2.00432	9.90099
102	320.44	8171.28	10404	1061208	10.0995	4.6723	2.00860	9.80392
103	323.58	8332.29	10609	1092727	10.1489	4.6875	2.01284	9.70874
104	326.73	8494.87	10816	1124864	10.1980	4.7027	2.01703	9.61538
105	329.87	8659.01	11025	1157625	10.2470	4.7177	2.02119	9.52381
106	333.01	8824.73	11236	1191016	10.2956	4.7326	2.02531	9.43396
107	336.15	8992.02	11449	1225043	10.3441	4.7475	2.02938	9.34579
108	339.29	9160.88	11664	1259712	10.3923	4.7622	2.03342	9.25926
109	342.43	9331.32	11881	1295029	10.4403	4.7769	2.03743	9.17431
110	345.58	9503.32	12100	1331000	10.4881	4.7914	2.04139	9.09091
111	348.72	9676.89	12321	1367631	10.5357	4.8059	2.04532	9.00901
112	351.86	9852.03	12544	1404928	10.5830	4.8203	2.04922	8.92857
113	355.00	10028.7	12769	1442897	10.6301	4.8346	2.05308	8.84956
114	358.14	10207.0	12996	1481544	10.6771	4.8488	2.05690	8.77193
115	361.28	10386.9	13225	1520875	10.7238	4.8629	2.06070	8.69565
116	364.42	10568.3	13456	1560896	10.7703	4.8770	2.06446	8.62069
117	367.57	10751.3	13689	1601613	10.8167	4.8910	2.06819	8.54701
118	370.71	10935.9	13924	1643032	10.8628	4.9049	2.07188	8.47458
119	373.85	11122.0	14161	1685159	10.9087	4.9187	2.07555	8.40336
120	376.99	11309.7	14400	1728000	10.9545	4.9324	2.07918	8.33333
121	380.13	11499.0	14641	1771561	11.0000	4.9461	2.08279	8.26446
122	383.27	11689.9	14884	1815848	11.0454	4.9597	2.08636	8.19672
123	386.42	11882.3	15129	1860867	11.0905	4.9732	2.08991	8.13008
124	389.56	12076.3	15376	1906624	11.1355	4.9866	2.09342	8.06452
125	392.70	12271.8	15625	1953125	11.1803	5.0000	2.09691	8.00000
126	395.84	12469.0	15876	2000376	11.2250	5.0133	2.10037	7.93651
127	398.98	12667.7	16129	2048383	11.2694	5.0265	2.10380	7.87402
128	402.12	12868.0	16384	2097152	11.3137	5.0397	2.10721	7.81250
129	405.27	13069.8	16641	2146689	11.3578	5.0528	2.11059	7.75194
130	408.41	13273.2	16900	2197000	11.4018	5.0658	2.11394	7.69231
131	411.55	13478.2	17161	2248091	11.4455	5.0788	2.11727	7.63359
132	414.69	13684.8	17424	2299968	11.4891	5.0916	2.12057	7.57576
133	417.83	13892.9	17689	2352637	11.5326	5.1045	2.12385	7.51880
134	420.97	14102.6	17956	2406104	11.5758	5.1172	2.12710	7.46269
135	424.12	14313.9	18225	2460375	11.6190	5.1299	2.13033	7.40741
136	427.26	14526.7	18496	2515456	11.6619	5.1426	1.13354	7.35294
137	430.40	14741.1	18769	2571353	11.7047	5.1551	2.13672	7.29927
138	433.54	14957.1	19044	2628072	11.7473	5.1676	2.13988	7.24638
139	436.68	15174.7	19321	2685619	11.7898	5.1801	2.14301	7.19424
140	439.82	15393.8	19600	2744000	11.8322	5.1925	2.14613	7.14286
141	442.96	15614.5	19881	2803221	11.8743	5.2048	2.14922	7.09220
142	446.11	15836.8	20164	2863288	11.9164	5.2171	2.15229	7.04225
143	449.25	16060.6	20449	2924207	11.9583	5.2293	2.15534	6.99301
144	452.39	16286.0	20736	2985984	12.0000	5.2415	2.15836	6.94444
145	455.53	16513.0	21025	3048625	12.0416	5.2536	2.16137	6.89655
146	458.67	16741.5	21316	3112136	12.0830	5.2656	2.16435	6.84932
147	461.81	16971.7	21609	3176523	12.1244	5.2776	2.16732	6.80272
148	464.96	17203.4	21904	3241792	12.1655	5.2896	2.17026	6.75676
149	468.10	17436.6	22201	3307949	12.2066	5.3015	2.17319	6.71141

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
150	471.24	17671.5	22500	3375000	12.2474	5.3133	2.17609	6.66667
151	474.38	17907.9	22801	3442951	12.2882	5.3251	2.17898	6.62252
152	477.52	18145.8	23104	3511808	12.3288	5.3368	2.18184	6.57895
153	480.66	18385.4	23409	3581577	12.3693	5.3485	2.18469	6.53595
154	483.81	18626.5	23716	3652264	12.4097	5.3601	2.18752	6.49351
155	486.95	18869.2	24025	3723875	12.4499	5.3717	2.19033	6.45161
156	490.09	19113.4	24336	3796416	12.4900	5.3832	2.19312	6.41026
157	493.23	19359.3	24649	3869893	12.5300	5.3947	2.19590	6.36943
158	496.37	19606.7	24964	3944312	12.5698	5.4061	2.19866	6.32911
159	499.51	19855.7	25281	4019679	12.6095	5.4175	2.20140	6.28931
160	502.65	20106.2	25600	4096000	12.6491	5.4288	2.20412	6.25000
161	505.80	20358.3	25921	4173281	12.6886	5.4401	2.20683	6.21118
162	508.94	20612.0	26244	4251528	12.7279	5.4514	2.20952	6.17284
163	512.08	20867.2	26569	4330747	12.7671	5.4626	2.21219	6.13497
164	515.22	21124.1	26896	4410944	12.8062	5.4737	2.21484	6.09756
165	518.36	21382.5	27225	4492125	12.8452	5.4848	2.21748	6.06061
166	521.50	21642.4	27556	4574296	12.8841	5.4959	2.22011	6.02410
167	524.65	21904.0	27889	4657463	12.9228	5.5069	2.22272	5.98802
168	527.79	22167.1	28224	4741632	12.9615	5.5178	2.22531	5.95238
169	530.93	22431.8	28561	4826809	13.0000	5.5288	2.22789	5.91716
170	534.07	22698.0	28900	4913000	13.0384	5.5397	2.23045	5.88235
171	537.21	22965.8	29241	5000211	13.0767	5.5505	2.23300	5.84795
172	540.35	23235.2	29584	5088448	13.1149	5.5613	2.23553	5.81395
173	543.50	23506.2	29929	5177717	13.1529	5.5721	2.23805	5.78035
174	546.64	23778.7	30276	5268024	13.1909	5.5828	2.24055	5.74713
175	549.78	24052.8	30625	5359375	13.2288	5.5934	2.24304	5.71429
176	552.92	24328.5	30976	5451776	13.2665	5.6041	2.24551	5.68182
177	556.06	24605.7	31329	5545233	13.3041	5.6147	2.24797	5.64972
178	559.20	24884.6	31684	5639752	13.3417	5.6252	2.25042	5.61798
179	562.35	25164.9	32041	5735339	13.3791	5.6357	2.25285	5.58659
180	565.49	25446.9	32400	5832000	13.4164	5.6462	2.25527	5.55556
181	568.63	25730.4	32761	5929741	13.4536	5.6567	2.25768	5.52486
182	571.77	26015.5	33124	6028568	13.4907	5.6671	2.26007	5.49451
183	574.91	26302.2	33489	6128487	13.5277	5.6774	2.26245	5.46448
184	578.05	26590.4	33856	6229504	13.5647	5.6877	2.26482	5.43478
185	581.19	26880.3	34225	6331625	13.6015	5.6980	2.26717	5.40541
186	584.34	27171.6	34596	6434856	13.6382	5.7083	2.26951	5.37634
187	587.48	27464.6	34969	6539203	13.6748	5.7185	2.27184	5.34759
188	590.62	27759.1	35344	6644672	13.7113	5.7287	2.27416	5.31915
189	593.76	28055.2	35721	6751269	13.7477	5.7388	2.27646	5.29101
190	596.90	28352.9	36100	6859000	13.7840	5.7489	2.27875	5.26316
191	600.04	28652.1	36481	6967871	13.8203	5.7590	2.28103	5.23560
192	603.19	28952.9	36864	7077888	13.8564	5.7690	2.28330	5.20833
193	606.33	29255.3	37249	7189057	13.8924	5.7790	2.28556	5.18135
194	609.47	29559.2	37636	7301384	13.9284	5.7890	2.28780	5.15464
195	612.61	29864.8	38025	7414875	13.9642	5.7989	2.29003	5.12821
196	615.75	30171.9	38416	7529536	14.0000	5.8088	2.29226	5.10204
197	618.89	30480.5	38809	7645373	14.0357	5.8186	2.29447	5.07614
198	622.04	30790.7	39204	7762392	14.0712	5.8285	2.29667	5.05051
199	625.18	31102.6	39601	7880599	14.1067	5.8383	2.29885	5.02513

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	*No. = Diam.* *Circum.*	*No. = Diam.* *Area.*	*Square.*	*Cube.*	*Square Root.*	*Cube Root.*	*Log.*	*1000 × Recip.*
200	628.32	31415.9	40000	8000000	14.1421	5.8480	2.30103	5.00000
201	631.46	31730.9	40401	8120601	14.1774	5.8578	2.30320	4.97512
202	634.60	32047.4	40804	8242408	14.2127	5.8675	2.30535	4.95050
203	637.74	32365.5	41209	8365427	14.2478	5.8771	2.30750	4.92611
204	640.89	32685.1	41616	8489664	14.2829	5.8868	2.30963	4.90196
205	644.03	33006.4	42025	8615125	14.3178	5.8964	2.31175	4.87805
206	647.17	33329.2	42436	8741816	14.3527	5.9059	2.31387	4.85437
207	650.31	33653.5	42849	8869743	14.3875	5.9155	2.31597	4.83092
208	653.45	33979.5	43264	8998912	14.4222	5.9250	2.31806	4.80769
209	656.59	34307.0	43681	9129329	14.4568	5.9345	2.32015	4.78469
210	659.73	34636.1	44100	9261000	14.4914	5.9439	2.32222	4.76190
211	662.88	34966.7	44521	9393931	14.5258	5.9533	2.32428	4.73934
212	666.02	35298.9	44944	9528128	14.5602	5.9627	2.32634	4.71698
213	669.16	35632.7	45369	9663597	14.5945	5.9721	2.32838	4.69484
214	672.30	35968.1	45796	9800344	14.6287	5.9814	2.33041	4.67290
215	675.44	36305.0	46225	9938375	14.6629	5.9907	2.33244	4.65116
216	678.58	36643.5	46656	10077696	14.6969	6.0000	2.33445	4.62963
217	681.73	36983.6	47089	10218313	14.7309	6.0092	2.33646	4.60829
218	684.87	37325.3	47524	10360232	14.7648	6.0185	2.33846	4.58716
219	688.01	37668.5	47961	10503459	14.7986	6.0277	2.34044	4.56621
220	691.15	38013.3	48400	10648000	14.8324	6.0368	2.34242	4.54545
221	694.29	38359.6	48841	10793861	14.8661	6.0459	2.34439	4.52489
222	697.43	38707.6	49284	10941048	14.8997	6.0550	2.34635	4.50450
223	700.58	39057.1	49729	11089567	14 9332	6.0641	2.34830	4.48431
224	703.72	39408.1	50176	11239424	14.9666	6.0732	2.35025	4.46429
225	706.86	39760.8	50625	11390625	15.0000	6.0822	2.35218	4.44444
226	710.00	40115.0	51076	11543176	15.0333	6.0912	2.35411	4.42478
227	713.14	40470.8	51529	11697083	15.0665	6.1002	2.35603	4.40529
228	716.28	40828.1	51984	11852352	15.0997	6.1091	2.35793	4.38596
229	719.42	41187.1	52441	12008989	15.1327	6.1180	2.35984	4.36681
230	722.57	41547.6	52900	12167000	15.1658	6.1269	2.36173	4.34783
231	725.71	41909.6	53361	12326391	15.1987	6.1358	2.36361	4.32900
232	728.85	42273.3	53824	12487168	15.2315	6.1446	2.36549	4.31034
233	731.99	42638.5	54289	12649337	15.2643	6.1534	2.36736	4.29185
234	735.13	43005.3	54756	12812904	15.2971	6.1622	2.36922	4.27350
235	738.27	43373.6	55225	12977875	15.3297	6.1710	2.37107	4.25532
236	741.42	43743.5	55696	13144256	15.3623	6.1797	2.37291	4.23729
237	744.56	44115.0	56169	13312053	15.3948	6.1885	2.37475	4.21941
238	747.70	44488.1	56644	13481272	15.4272	6.1972	2.37658	4.20168
239	750.84	44862.7	57121	13651919	15.4596	6.2058	2.37840	4.18410
240	753.98	45238.9	57600	13824000	15.4919	6.2145	2.38021	4.16667
241	757.12	45616.7	58081	13997521	15.5242	6.2231	2.38202	4.14938
242	760.27	45996.1	58564	14172488	15.5563	6.2317	2.38382	4.13223
243	763.41	46377.0	59049	14348907	15.5885	6.2403	2.38561	4.11523
244	766.55	46759.5	59536	14526784	15.6205	6.2488	2.38739	4.09836
245	769.69	47143.5	60025	14706125	15.6525	6.2573	2.38917	4.08163
246	772.83	47529.2	60516	14886936	15.6844	6.2658	2.39094	4.06504
247	775.97	47916.4	61009	15069223	15.7162	6.2743	2.39270	4.04858
248	779.12	48305.1	61504	15252992	15.7480	6.2828	2.39445	4.03226
249	782.26	48695.5	62001	15438249	15.7797	6.2912	2.39620	4.01606

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
250	785.40	49087.4	62500	15625000	15.8114	6.2996	2.39794	4.00000
251	788.54	49480.9	63001	15813251	15.8430	6.3080	2.39967	3.98406
252	791.68	49875.9	63504	16003008	15.8745	6.3164	2.40140	3.96825
253	794.82	50272.6	64009	16194277	15.9060	6.3247	2.40312	3.95257
254	797.96	50670.7	64516	16387064	15.9374	6.3330	2.40483	3.93701
255	801.11	51070.5	65025	16581375	15.9687	6.3413	2.40654	3.92157
256	804.25	51471.9	65536	16777216	16.0000	6.3496	2.40824	3.90625
257	807.39	51874.8	66049	16974593	16.0312	6.3579	2.40993	3.89105
258	810.53	52279.2	66564	17173512	16.0624	6.3661	2.41162	3.87597
259	813.67	52685.3	67081	17373979	16.0935	6.3743	2.41330	3.86100
260	816.81	53092.9	67600	17576000	16.1245	6.3825	2.41497	3.84615
261	819.96	53502.1	68121	17779581	16.1555	6.3907	2.41664	3.83142
262	823.10	53912.9	68644	17984728	16.1864	6.3988	2.41830	3.81679
263	826.24	54325.2	69169	18191447	16.2173	6.4070	2.41996	3.80228
264	829.38	54739.1	69696	18399744	16.2481	6.4151	2.42160	3.78788
265	832.52	55154.6	70225	18609625	16.2788	6.4232	2.42325	3.77358
266	835.66	55571.6	70756	18821096	16.3095	6.4312	2.42488	3.75940
267	838.81	55990.3	71289	19034163	16.3401	6.4393	2.42651	3.74532
268	841.95	56410.4	71824	19248832	16.3707	6.4473	2.42813	3.73134
269	845.09	56832.2	72361	19465109	16.4012	6.4553	2.42975	3.71747
270	848.23	57255.5	72900	19683000	16.4317	6.4633	2.43136	3.70370
271	851.37	57680.4	73441	19902511	16.4621	6.4713	2.43297	3.69004
272	854.51	58106.9	73984	20123648	16.4924	6.4792	2.43457	3.67647
273	857.66	58534.9	74529	20346417	16.5227	6.4872	2.43616	3.66300
274	860.80	58964.6	75076	20570824	16.5529	6.4951	2.43775	3.64964
275	863.94	59395.7	75625	20796875	16.5831	6.5030	2.43933	3.63636
276	867.08	59828.5	76176	21024576	16.6132	6.5108	2.44091	3.62319
277	870.22	60262.8	76729	21253933	16.6433	6.5187	2.44248	3.61011
278	873.36	60698.7	77284	21484952	16.6733	6.5265	2.44404	3.59712
279	876.50	61136.2	77841	21717639	16.7033	6.5343	2.44560	3.58423
280	879.65	61575.2	78400	21952000	16.7332	6.5421	2.44716	3.57143
281	882.79	62015.8	78961	22188041	16.7631	6.5499	2.44871	3.55872
282	885.93	62458.0	79524	22425768	16.7929	6.5577	2.45025	3.54610
283	889.07	62901.8	80089	22665187	16.8226	6.5654	2.45179	3.53357
284	892.21	63347.1	80656	22906304	16.8523	6.5731	2.45332	3.52113
285	895.35	63794.0	81225	23149125	16.8819	6.5808	2.45484	3.50877
286	898.50	64242.4	81796	23393656	16.9115	6.5885	2.45637	3.49650
287	901.64	64692.5	82369	23639903	16.9411	6.5962	2.45788	3.48432
288	904.78	65144.1	82944	23887872	16.9706	6.6039	2.45939	3.47222
289	907.92	65597.2	83521	24137569	17.0000	6.6115	2.46090	3.46021
290	911.06	66052.0	84100	24389000	17.0294	6.6191	2.46240	3.44828
291	914.20	66508.3	84681	24642171	17.0587	6.6267	2.46389	3.43643
292	917.35	66966.2	85264	24897088	17.0880	6.6343	2.46538	3.42466
293	920.49	67425.6	85849	25153757	17.1172	6.6419	2.46687	3.41297
294	923.63	67886.7	86436	25412184	17.1464	6.6494	2.46835	3.40136
295	926.77	68349.3	87025	25672375	17.1756	6.6569	2.46982	3.38983
296	929.91	68813.5	87616	25934336	17.2047	6.6644	2.47129	3.37838
297	933.05	69279.2	88209	26198073	17.2337	6.6719	2.47276	3.36700
298	936.19	69746.5	88804	26463592	17.2627	6.6794	2.47422	3.35570
299	939.34	70215.4	89401	26730899	17.2916	6.6869	2.47567	3.34448

CIRCUMFERENCES CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
300	942.48	70685.8	90000	27000000	17.3205	6.6943	2.47712	3.33333
301	945.62	71157.9	90601	27270901	17.3494	6.7018	2.47857	3.32226
302	948.76	71631.5	91204	27543608	17.3781	6.7092	2.48001	3.31126
303	951.90	72106.6	91809	27818127	17.4069	6.7166	2.48144	3.30033
304	955.04	72583.4	92416	28094464	17.4356	6.7240	2.48287	3.28947
305	958.19	73061.7	93025	28372625	17.4642	6.7313	2.48430	3.27869
306	961.33	73541.5	93636	28652616	17.4929	6.7387	2.48572	3.26797
307	964.47	74023.0	94249	28934443	17.5214	6.7460	2.48714	3.25733
308	967.61	74506.0	94864	29218112	17.5499	6.7533	2.48855	3.24675
309	970.75	74990.6	95481	29503629	17.5784	6.7606	2.48996	3.23625
310	973.89	75476.8	96100	29791000	17.6068	6.7679	2.49136	3.22581
311	977.04	75964.5	96721	30080231	17.6352	6.7752	2.49276	3.21543
312	980.18	76453.8	97344	30371328	17.6635	6.7824	2.49415	3.20513
313	983.32	76944.7	97969	30664297	17.6918	6.7897	2.49554	3.19489
314	986.46	77437.1	98596	30959144	17.7200	6.7969	2.49693	3.18471
315	989.60	77931.1	99225	31255875	17.7482	6.8041	2.49831	3.17460
316	992.74	78426.7	99856	31554496	17.7764	6.8113	2.49969	3.16456
317	995.88	78923.9	100489	31855013	17.8045	6.8185	2.50106	3.15457
318	999.03	79422.6	101124	32157432	17.8326	6.8256	2.50243	3.14465
319	1002.2	79922.9	101761	32461759	17.8606	6.8328	2.50379	3.13480
320	1005.3	80424.8	102400	32768000	17.8885	6.8399	2.50515	3.12500
321	1008.5	80928.2	103041	33076161	17.9165	6.8470	2.50651	3.11527
322	1011.6	81433.2	103684	33386248	17.9444	6.8541	2.50786	3.10559
323	1014.7	81939.8	104329	33698267	17.9722	6.8612	2.50920	3.09598
324	1017.9	82448.0	104976	34012224	18.0000	6.8683	2.51055	3.08642
325	1021.0	82957.7	105625	34328125	18.0278	6.8753	2.51188	3.07692
326	1024.2	83469.0	106276	34645976	18.0555	6.8824	2.51322	3.06749
327	1027.3	83981.8	106929	34965783	18.0831	6.8894	2.51455	3.05810
328	1030.4	84496.3	107584	35287552	18.1108	6.8964	2.51587	3.04878
329	1033.6	85012.3	108241	35611289	18.1384	6.9034	2.51720	3.03951
330	1036.7	85529.9	108900	35937000	18.1659	6.9104	2.51851	3.03030
331	1039.9	86049.0	109561	36264691	18.1934	6.9174	2.51983	3.02115
332	1043.0	86569.7	110224	36594368	18.2209	6.9244	2.52114	3.01205
333	1046.2	87092.0	110889	36926037	18.2483	6.9313	2.52244	3.00300
334	1049.3	87615.9	111556	37259704	18.2757	6.9382	2.52375	2.99401
335	1052.4	88141.3	112225	37595375	18.3030	6.9451	2.52504	2.98507
336	1055.6	88668.3	112896	37933056	18.3303	6.9521	2.52634	2.97619
337	1058.7	89196.9	113569	38272753	18.3576	6.9589	2.52763	2.96736
338	1061.9	89727.0	114244	38614472	18.3848	6.9658	2.52892	2.95858
339	1065.0	90258.7	114921	38958219	18.4120	6.9727	2.53020	2.94985
340	1068.1	90792.0	115600	39304000	18.4391	6.9795	2.53148	2.94118
341	1071.3	91326.9	116281	39651821	18.4662	6.9864	2.53275	2.93255
342	1074.4	91863.3	116964	40001688	18.4932	6.9932	2.53403	2.92398
343	1077.6	92401.3	117649	40353607	18.5203	7.0000	2.53529	2.91545
344	1080.7	92940.9	118336	40707584	18.5472	7.0068	2.53656	2.90698
345	1083.8	93482.0	119025	41063625	18.5742	7.0136	2.53782	2.89855
346	1087.0	94024.7	119716	41421736	18.6011	7.0203	2.53908	2.89017
347	1090.1	94569.0	120409	41781923	18.6279	7.0271	2.54033	2.88184
348	1093.3	95114.9	121104	42144192	18.6548	7.0338	2.54158	2.87356
349	1096.4	95662.3	121801	42508549	18.6815	7.0406	2.54283	2.86533

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	*No. = Diam.*		*Square.*	*Cube.*	*Square Root.*	*Cube Root.*	*Log.*	*1000 × Recip.*
	Circum.	*Area.*						
350	1099.6	96211.3	122500	42875000	18.7083	7.0473	2.54407	2.85714
351	1102.7	96761.8	123201	43243551	18.7350	7.0540	2.54531	2.84900
352	1105.8	97314.0	123904	43614208	18.7617	7.0607	2.54654	2.84091
353	1109.0	97867.7	124609	43986977	18.7883	7.0674	2.54777	2.83286
354	1112.1	98423.0	125316	44361864	18.8149	7.0740	2.54900	2.82486
355	1115.3	98979.8	126025	44738875	18.8414	7.0807	2.55023	2.81690
356	1118.4	99538.2	126736	45118016	18.8680	7.0873	2.55145	2.80899
357	1121.5	100098	127449	45499293	18.8944	7.0940	2.55267	2.80112
358	1124.7	100660	128164	45882712	18.9209	7.1006	2.55388	2.79330
359	1127.8	101223	128881	46268279	18.9473	7.1072	2.55509	2.78552
360	1131.0	101788	129600	46656000	18.9737	7.1138	2.55630	2.77778
361	1134.1	102354	130321	47045881	19.0000	7.1204	2.55751	2.77008
362	1137.3	102922	131044	47437928	19.0263	7.1269	2.55871	2.76243
363	1140.4	103491	131769	47832147	19.0526	7.1335	2.55991	2.75482
364	1143.5	104062	132496	48228544	19.0788	7.1400	2.56110	2.74725
365	1146.7	104635	133225	48627125	19.1050	7.1466	2.56229	2.73973
366	1149.8	105209	133956	49027896	19.1311	7.1531	2.56348	2.73224
367	1153.0	105785	134689	49430863	19.1572	7.1596	2.56467	2.72480
368	1156.1	106362	135424	49836032	19.1833	7.1661	2.56585	2.71739
369	1159.2	106941	136161	50243409	19.2094	7.1726	2.56703	2.71003
370	1162.4	107521	136900	50653000	19.2354	7.1791	2.56820	2.70270
371	1165.5	108103	137641	51064811	19.2614	7.1855	2.56937	2.69542
372	1168.7	108687	138384	51478848	19.2873	7.1920	2.57054	2.68817
373	1171.8	109272	139129	51895117	19.3132	7.1984	2.57171	2.68097
374	1175.0	109858	139876	52313624	19.3391	7.2048	2.57287	2.67380
375	1178.1	110447	140625	52734375	19.3649	7.2112	2.57403	2.66667
376	1181.2	111036	141376	53157376	19.3907	7.2177	2.57519	2.65957
377	1184.4	111628	142129	53582633	19.4165	7.2240	2.57634	2.65252
378	1187.5	112221	142884	54010152	19.4422	7.2304	2.57749	2.64550
379	1190.7	112815	143641	54439939	19.4679	7.2368	2.57864	2.63852
380	1193.8	113411	144400	54872000	19.4936	7.2432	2.57978	2.63158
381	1196.9	114009	145161	55306341	19.5192	7.2495	2.58093	2.62467
382	1200.1	114608	145924	55742968	19.5448	7.2558	2.58206	2.61780
383	1203.2	115209	146689	56181887	19.5704	7.2622	2.58320	2.61097
384	1206.4	115812	147456	56623104	19.5959	7.2685	2.58433	2.60417
385	1209.5	116416	148225	57066625	19.6214	7.2748	2.58546	2.59740
386	1212.7	117021	148996	57512456	19.6469	7.2811	2.58659	2.59067
387	1215.8	117628	149769	57960603	19.6723	7.2874	2.58771	2.58398
388	1218.9	118237	150544	58411072	19.6977	7.2936	2.58883	2.57732
389	1222.1	118847	151321	58863869	19.7231	7.2999	2.58995	2.57069
390	1225.2	119459	152100	59319000	19.7484	7.3061	2.59106	2.56410
391	1228.4	120072	152881	59776471	19.7737	7.3124	2.59218	2.55755
392	1231.5	120687	153664	60236288	19.7990	7.3186	2.59329	2.55102
393	1234.6	121304	154449	60698457	19.8242	7.3248	2.59439	2.54453
394	1237.8	121922	155236	61162984	19.8494	7.3310	2.59550	2.53807
395	1240.9	122542	156025	61629875	19.8746	7.3372	2.59660	2.53165
396	1244.1	123163	156816	62099136	19.8997	7.3434	2.59770	2.52525
397	1247.2	123786	157609	62570773	19.9249	7.3496	2.59879	2.51889
398	1250.4	124410	158404	63044792	19.9499	7.3558	2.59988	2.51256
399	1253.5	125036	159201	63521199	19.9750	7.3619	2.60097	2.50627

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam. Circum.	No. = Diam. Area.	Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
400	1256.6	125664	160000	64000000	20.0000	7.3681	2.60206	2.50000
401	1259.8	126293	160801	64481201	20.0250	7.3742	2.60314	2.49377
402	1262.9	126923	161604	64964808	20.0499	7.3803	2.60423	2.48756
403	1266.1	127556	162409	65450827	20.0749	7.3864	2.60531	2.48139
404	1269.2	128190	163216	65939264	20.0998	7.3925	2.60638	2.47525
405	1272.3	128825	164025	66430125	20.1246	7.3986	2.60746	2.46914
406	1275.5	129462	164836	66923416	20.1494	7.4047	2.60853	2.46305
407	1278.6	130100	165649	67419143	20.1742	7.4108	2.60959	2.45700
408	1281.8	130741	166464	67917312	20.1990	7.4169	2.61066	2.45098
409	1284.9	131382	167281	68417929	20.2237	7.4229	2.61172	2.44499
410	1288.1	132025	168100	68921000	20.2485	7.4290	2.61278	2.43902
411	1291.2	132670	168921	69426531	20.2731	7.4350	2.61384	2.43309
412	1294.3	133317	169744	69934528	20.2978	7.4410	2.61490	2.42718
413	1297.5	133965	170569	70444997	20.3224	7.4470	2.61595	2.42131
414	1300.6	134614	171396	70957944	20.3470	7.4530	2.61700	2.41546
415	1303.8	135265	172225	71473375	20.3715	7.4590	2.61805	2.40964
416	1306.9	135918	173056	71991296	20.3961	7.4650	2.61909	2.40385
417	1310.0	136572	173889	72511713	20.4206	7.4710	2.62014	2.39808
418	1313.2	137228	174724	73034632	20.4450	7.4770	2.62118	2.39234
419	1316.3	137885	175561	73560059	20.4695	7.4829	2.62221	2.38664
420	1319.5	138544	176400	74088000	20.4939	7.4889	2.62325	2.38095
421	1322.6	139205	177241	74618461	20.5183	7.4948	2.62428	2.37530
422	1325.8	139867	178084	75151448	20.5426	7.5007	2.62531	2.36967
423	1328.9	140531	178929	75686967	20.5670	7.5067	2.62634	2.36407
424	1332.0	141196	179776	76225024	20.5913	7.5126	2.62737	2.35849
425	1335.2	141863	180625	76765625	20.6155	7.5185	2.62839	2.35294
426	1338.3	142531	181476	77308776	20.6398	7.5244	2.62941	2.34742
427	1341.5	143201	182329	77854483	20.6640	7.5302	2.63043	2.34192
428	1344.6	143872	183184	78402752	20.6882	7.5361	2.63144	2.33645
429	1347.7	144545	184041	78953589	20.7123	7.5420	2.63246	2.33100
430	1350.9	145220	184900	79507000	20.7364	7.5478	2.63347	2.32558
431	1354.0	145896	185761	80062991	20.7605	7.5537	2.63448	2.32019
432	1357.2	146574	186624	80621568	20.7846	7.5595	2.63548	2.31482
433	1360.3	147254	187489	81182737	20.8087	7.5654	2.63649	2.30947
434	1363.5	147934	188356	81746504	20.8327	7.5712	2.63749	2.30415
435	1366.6	148617	189225	82312875	20.8567	7.5770	2.63849	2.29885
436	1369.7	149301	190096	82881856	20.8806	7.5828	2.63949	2.29358
437	1372.9	149987	190969	83453453	20.9045	7.5886	2.64048	2.28833
438	1376.0	150674	191844	84027672	20.9284	7.5944	2.64147	2.28311
439	1379.2	151363	192721	84604519	20.9523	7.6001	2.64246	2.27790
440	1382.3	152053	193600	85184000	20.9762	7.6059	2.64345	2.27273
441	1385.4	152745	194481	85766121	21.0000	7.6117	2.64444	2.26757
442	1388.6	153439	195364	86350888	21.0238	7.6174	2.64542	2.26244
443	1391.7	154134	196249	86938307	21.0476	7.6232	2.64640	2.25734
444	1394.9	154830	197136	87528384	21.0713	7.6289	2.64738	2.25225
445	1398.0	155528	198025	88121125	21.0950	7.6346	2.64836	2.24719
446	1401.2	156228	198916	88716536	21.1187	7.6403	2.64933	2.24215
447	1404.3	156930	199809	89314623	21.1424	7.6460	2.65031	2.23714
448	1407.4	157633	200704	89915392	21.1660	7.6517	2.65128	2.23214
449	1410.6	158337	201601	90518849	21.1896	7.6574	2.65225	2.22717

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
450	1413.7	159043	202500	91125000	21.2132	7.6631	2.65321	2.22222
451	1416.9	159751	203401	91733851	21.2368	7.6688	2.65418	2.21730
452	1420.0	160460	204304	92345408	21.2603	7.6744	2.65514	2.21239
453	1423.1	161171	205209	92959677	21.2838	7.6801	2.65610	2.20751
454	1426.3	161883	206116	93576664	21.3073	7.6857	2.65706	2.20264
455	1429.4	162597	207025	94196375	21.3307	7.6914	2.65801	2.19780
456	1432.6	163313	207936	94818816	21.3542	7.6970	2.65896	2.19298
457	1435.7	164030	208849	95443993	21.3776	7.7026	2.65992	2.18818
458	1438.9	164748	209764	96071912	21.4009	7.7082	2.66087	2.18341
459	1442.0	165468	210681	96702579	21.4243	7.7138	2.66181	2.17865
460	1445.1	166190	211600	97336000	21.4476	7.7194	2.66276	2.17391
461	1448.3	166914	212521	97972181	21.4709	7.7250	2.66370	2.16920
462	1451.4	167639	213444	98611128	21.4942	7.7306	2.66464	2.16450
463	1454.6	168365	214369	99252847	21.5174	7.7362	2.66558	2.15983
464	1457.7	169093	215296	99897344	21.5407	7.7418	2.66652	2.15517
465	1460.8	169823	216225	100544625	21.5639	7.7473	2.66745	2.15054
466	1464.0	170554	217156	101194696	21.5870	7.7529	2.66839	2.14592
467	1467.1	171287	218089	101847563	21.6102	7.7584	2.66932	2.14133
468	1470.3	172021	219024	102503232	21.6333	7.7639	2.67025	2.13675
469	1473.4	172757	219961	103161709	21.6564	7.7695	2.67117	2.13220
470	1476.5	173494	220900	103823000	21.6795	7.7750	2.67210	2.12766
471	1479.7	174234	221841	104487111	21.7025	7.7805	2.67302	2.12314
472	1482.8	174974	222784	105154048	21.7256	7.7860	2.67394	2.11864
473	1486.0	175716	223729	105823817	21.7486	7.7915	2.67486	2.11417
474	1489.1	176460	224676	106496424	21.7715	7.7970	2.67578	2.10971
475	1492.3	177205	225625	107171875	21.7945	7.8025	2.67669	2.10526
476	1495.4	177952	226576	107850176	21.8174	7.8079	2.67761	2.10084
477	1498.5	178701	227529	108531333	21.8403	7.8134	2.67852	2.09644
478	1501.7	179451	228484	109215352	21.8632	7.8188	2.67943	2.09205
479	1504.8	180203	229441	109902239	21.8861	7.8243	2.68034	2.08768
480	1508.0	180956	230400	110592000	21.9089	7.8297	2.68124	2.08333
481	1511.1	181711	231361	111284641	21.9317	7.8352	2.68215	2.07900
482	1514.3	182467	232324	111980168	21.9545	7.8406	2.68305	2.07469
483	1517.4	183225	233289	112678587	21.9773	7.8460	2.68395	2.07039
484	1520.5	183984	234256	113379904	22.0000	7.8514	2.68485	2.06612
485	1523.7	184745	235225	114084125	22.0227	7.8568	2.68574	2.06186
486	1526.8	185508	236196	114791256	22.0454	7.8622	2.68664	2.05761
487	1530.0	186272	237169	115501303	22.0681	7.8676	2.68753	2.05339
488	1533.1	187038	238144	116214272	22.0907	7.8730	2.68842	2.04918
489	1536.2	187805	239121	116930169	22.1133	7.8784	2.68931	2.04499
490	1539.4	188574	240100	117649000	22.1359	7.8837	2.69020	2.04082
491	1542.5	189345	241081	118370771	22.1585	7.8891	2.69108	2.03666
492	1545.7	190117	242064	119095488	22.1811	7.8944	2.69197	2.03252
493	1548.8	190890	243049	119823157	22.2036	7.8998	2.69285	2.02840
494	1551.9	191665	244036	120553784	22.2261	7.9051	2.69373	2.02429
495	1555.1	192442	245025	121287375	22.2486	7.9105	2.69461	2.02020
496	1558.2	193221	246016	122023936	22.2711	7.9158	2.69548	2.01613
497	1561.4	194000	247009	122763473	22.2935	7.9211	2.69636	2.01207
498	1564.5	194782	248004	123505992	22.3159	7.9264	2.69723	2.00803
499	1567.7	195565	249001	124251499	22.3383	7.9317	2.69810	2.00401

CIRCUMFERENCES CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
500	1570.8	196350	250000	125000000	22.3607	7.9370	2.69897	2.00000
501	1573.9	197136	251001	125751501	22.3830	7.9423	2.69984	1.99601
502	1577.1	197923	252004	126506008	22.4054	7.9476	2.70070	1.99203
503	1580.2	198713	253009	127263527	22.4277	7.9528	2.70157	1.98807
504	1583.4	199504	254016	128024064	22.4499	7.9581	2.70243	1.98413
505	1586.5	200296	255025	128787625	22.4722	7.9634	2.70329	1.98020
506	1589.7	201090	256036	129554216	22.4944	7.9686	2.70415	1.97629
507	1592.8	201886	257049	130323843	22.5167	7.9739	2.70501	1.97239
508	1595.9	202683	258064	131096512	22.5389	7.9791	2.70586	1.96850
509	1599.1	203482	259081	131872229	22.5610	7.9843	2.70672	1.96464
510	1602.2	204282	260100	132651000	22.5832	7.9896	2.70757	1.96078
511	1605.4	205084	261121	133432831	22.6053	7.9948	2.70842	1.95695
512	1608.5	205887	262144	134217728	22.6274	8.0000	2.70927	1.95312
513	1611.6	206692	263169	135005697	22.6495	8.0052	2.71012	1.94932
514	1614.8	207499	264196	135796744	22.6716	8.0104	2.71096	1.94553
515	1617.9	208307	265225	136590875	22.6936	8.0156	2.71181	1.94175
516	1621.1	209117	266256	137388096	22.7156	8.0208	2.71265	1.93798
517	1624.2	209928	267289	138188413	22.7376	8.0260	2.71349	1.93424
518	1627.3	210741	268324	138991832	22.7596	8.0311	2.71433	1.93050
519	1630.5	211556	269361	139798359	22.7816	8.0363	2.71517	1.92678
520	1633.6	212372	270400	140608000	22.8035	8.0415	2.71600	1.92308
521	1636.8	213189	271441	141420761	22.8254	8.0466	2.71684	1.91939
522	1639.9	214008	272484	142236648	22.8473	8.0517	2.71767	1.91571
523	1643.1	214829	273529	143055667	22.8692	8.0569	2.71850	1.91205
524	1646.2	215651	274576	143877824	22.8910	8.0620	2.71933	1.90840
525	1649.3	216475	275625	144703125	22.9129	8.0671	2.72016	1.90476
526	1652.5	217301	276676	145531576	22.9347	8.0723	2.72099	1.90114
527	1655.6	218128	277729	146363183	22.9565	8.0774	2.72181	1.89753
528	1658.8	218956	278784	147197952	22.9783	8.0825	2.72263	1.89394
529	1661.9	219787	279841	148035889	23.0000	8.0876	2.72346	1.89036
530	1665.0	220618	280900	148877000	23.0217	8.0927	2.72428	1.88679
531	1668.2	221452	281961	149721291	23.0434	8.0978	2.72509	1.88324
532	1671.3	222287	283024	150568768	23.0651	8.1028	2.72591	1.87970
533	1674.5	223123	284089	151419437	23.0868	8.1079	2.72673	1.87617
534	1677.6	223961	285156	152273304	23.1084	8.1130	2.72754	1.87266
535	1680.8	224801	286225	153130375	23.1301	8.1180	2.72835	1.86916
536	1683.9	225642	287296	153990656	23.1517	8.1231	2.72916	1.86567
537	1687.0	226484	288369	154854153	23.1733	8.1281	2.72997	1.86220
538	1690.2	227329	289444	155720872	23.1948	8.1332	2.73078	1.85874
539	1693.3	228175	290521	156590819	23.2164	8.1382	2.73159	1.85529
540	1696.5	229022	291600	157464000	23.2379	8.1433	2.73239	1.85185
541	1699.6	229871	292681	158340421	23.2594	8.1483	2.73320	1.84843
542	1702.7	230722	293764	159220088	23.2809	8.1533	2.73400	1.84502
543	1705.9	231574	294849	160103007	23.3024	8.1583	2.73480	1.84162
544	1709.0	232428	295936	160989184	23.3238	8.1633	2.73560	1.83824
545	1712.2	233283	297025	161878625	23.3452	8.1683	2.73640	1.83486
546	1715.3	234140	298116	162771336	23.3666	8.1733	2.73719	1.83150
547	1718.5	234998	299209	163667323	23.3880	8.1783	2.73799	1.82815
548	1721.6	235858	300304	164566592	23.4094	8.1833	2.73878	1.82482
549	1724.7	236720	301401	165469149	23.4307	8.1882	2.73957	1.82149

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
550	1727.9	237583	302500	166375000	23.4521	8.1932	2.74036	1.81818
551	1731.0	238448	303601	167284151	23.4734	8.1982	2.74115	1.81488
552	1734.2	239314	304704	168196608	23.4947	8.2031	2.74194	1.81159
553	1737.3	240182	305809	169112377	23.5160	8.2081	2.74273	1.80832
554	1740.4	241051	306916	170031464	23.5372	8.2130	2.74351	1.80505
555	1743.6	241922	308025	170953875	23.5584	8.2180	2.74429	1.80180
556	1746.7	242795	309136	171879616	23.5797	8.2229	2.74507	1.79856
557	1749.9	243669	310249	172808693	23.6008	8.2278	2.74586	1.79533
558	1753.0	244545	311364	173741112	23.6220	8.2327	2.74663	1.79211
559	1756.2	245422	312481	174676879	23.6432	8.2377	2.74741	1.78891
560	1759.3	246301	313600	175616000	23.6643	8.2426	2.74819	1.78571
561	1762.4	247181	314721	176558481	23.6854	8.2475	2.74896	1.78253
562	1765.6	248063	315844	177504328	23.7065	8.2524	2.74974	1.77936
563	1768.7	248947	316969	178453547	23.7276	8.2573	2.75051	1.77620
564	1771.9	249832	318096	179406144	23.7487	8.2621	2.75128	1.77305
565	1775.0	250719	319225	180362125	23.7697	8.2670	2.75205	1.76991
566	1778.1	251607	320356	181321496	23.7908	8.2719	2.75282	1.76678
567	1781.3	252497	321489	182284263	23.8118	8.2768	2.75358	1.76367
568	1784.4	253388	322624	183250432	23.8328	8.2816	2.75435	1.76056
569	1787.6	254281	323761	184220009	23.8537	8.2865	2.75511	1.75747
570	1790.7	255176	324900	185193000	23.8747	8.2913	2.75587	1.75439
571	1793.9	256072	326041	186169411	23.8956	8.2962	2.75664	1.75131
572	1797.0	256970	327184	187149248	23.9165	8.3010	2.75740	1.74825
573	1800.1	257869	328329	188132517	23.9374	8.3059	2.75815	1.74520
574	1803.3	258770	329476	189119224	23.9583	8.3107	2.75891	1.74216
575	1806.4	259672	330625	190109375	23.9792	8.3155	2.75967	1.73913
576	1809.6	260576	331776	191102976	24.0000	8.3203	2.76042	1.73611
577	1812.7	261482	332929	192100033	24.0208	8.3251	2.76118	1.73310
578	1815.8	262389	334084	193100552	24.0416	8.3300	2.76193	1.73010
579	1819.0	263298	335241	194104539	24.0624	8.3348	2.76268	1.72712
580	1822.1	264208	336400	195112000	24.0832	8.3396	2.76343	1.72414
581	1825.3	265120	337561	196122941	24.1039	8.3443	2.76418	1.72117
582	1828.4	266033	338724	197137368	24.1247	8.3491	2.76492	1.71821
583	1831.6	266948	339889	198155287	24.1454	8.3539	2.76567	1.71527
584	1834.7	267865	341056	199176704	24.1661	8.3587	2.76641	1.71233
585	1837.8	268783	342225	200201625	24.1868	8.3634	2.76716	1.70940
586	1841.0	269701	343396	201230056	24.2074	8.3682	2.76790	1.70649
587	1844.1	270624	344569	202262003	24.2281	8.3730	2.76864	1.70358
588	1847.3	271547	345744	203297472	24.2487	8.3777	2.76938	1.70068
589	1850.4	272471	346921	204336469	24.2693	8.3825	2.77012	1.69779
590	1853.5	273397	348100	205379000	24.2899	8.3872	2.77085	1.69492
591	1856.7	274325	349281	206425071	24.3105	8.3919	2.77159	1.69205
592	1859.8	275254	350464	207474688	24.3311	8.3967	2.77232	1.68919
593	1863.0	276184	351649	208527857	24.3516	8.4014	2.77305	1.68634
594	1866.1	277117	352836	209584584	24.3721	8.4061	2.77379	1.68350
595	1869.3	278051	354025	210644875	24.3926	8.4108	2.77452	1.68067
596	1872.4	278986	355216	211708736	24.4131	8.4155	2.77525	1.67785
597	1875.5	279923	356409	212776173	24.4336	8.4202	2.77597	1.67504
598	1878.7	280862	357604	213847192	24.4540	8.4249	2.77670	1.67224
599	1881.8	281802	358801	214921799	24.4745	8.4296	2.77743	1.66945

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	*No. = Diam.*		*Square.*	*Cube.*	*Square Root.*	*Cube Root.*	*Log.*	*1000 × Recip.*
	Circum.	*Area.*						
600	1885.0	282743	360000	216000000	24.4949	8.4343	2.77815	1.66667
601	1888.1	283687	361201	217081801	24.5153	8.4390	2.77887	1.66389
602	1891.2	284631	362404	218167208	24.5357	8.4437	2.77960	1.66113
603	1894.4	285578	363609	219256227	24.5561	8.4484	2.78032	1.65837
604	1897.5	286526	364816	220348864	24.5764	8.4530	2.78104	1.65563
605	1900.7	287475	366025	221445125	24.5967	8.4577	2.78176	1.65289
606	1903.8	288426	367236	222545016	24.6171	8.4623	2.78247	1.65017
607	1907.0	289379	368449	223648543	24.6374	8.4670	2.78319	1.64745
608	1910.1	290333	369664	224755712	24.6577	8.4716	2.78390	1.64474
609	1913.2	291289	370881	225866529	24.6779	8.4763	2.78462	1.64204
610	1916.4	292247	372100	226981000	24.6982	8.4809	2.78533	1.63934
611	1919.5	293206	373321	228099131	24.7184	8.4856	2.78604	1.63666
612	1922.7	294166	374544	229220928	24.7386	8.4902	2.78675	1.63399
613	1925.8	295128	375769	230346397	24.7588	8.4948	2.78746	1.63132
614	1928.9	296092	376996	231475544	24.7790	8.4994	2.78817	1.62866
615	1932.1	297057	378225	232608375	24.7992	8.5040	2.78888	1.62602
616	1935.2	298024	379456	233744896	24.8193	8.5086	2.78958	1.62338
617	1938.4	298992	380689	234885113	24.8395	8.5132	2.79029	1.62075
618	1941.5	299962	381924	236029032	24.8596	8.5178	2.79099	1.61812
619	1944.7	300934	383161	237176659	24.8797	8.5224	2.79169	1.61551
620	1947.8	301907	384400	238328000	24.8998	8.5270	2.79239	1.61290
621	1950.9	302882	385641	239483061	24.9199	8.5316	2.79309	1.61031
622	1954.1	303858	386884	240641848	24.9399	8.5362	2.79379	1.60772
623	1957.2	304836	388129	241804367	24.9600	8.5408	2.79449	1.60514
624	1960.4	305815	389376	242970624	24.9800	8.5453	2.79518	1.60256
625	1963.5	306796	390625	244140625	25.0000	8.5499	2.79588	1.60000
626	1966.6	307779	391876	245314376	25.0200	8.5544	2.79657	1.59744
627	1969.8	308763	393129	246491883	25.0400	8.5590	2.79727	1.59490
628	1972.9	309748	394384	247673152	25.0599	8.5635	2.79796	1.59236
629	1976.1	310736	395641	248858189	25.0799	8.5681	2.79865	1.58983
630	1979.2	311725	396900	250047000	25.0998	8.5726	2.79934	1.58730
631	1982.4	312715	398161	251239591	25.1197	8.5772	2.80003	1.58479
632	1985.5	313707	399424	252435968	25.1396	8.5817	2.80072	1.58228
633	1988.6	314700	400689	253636137	25.1595	8.5862	2.80140	1.57978
634	1991.8	315696	401956	254840104	25.1794	8.5907	2.80209	1.57729
635	1994.9	316692	403225	256047875	25.1992	8.5952	2.80277	1.57480
636	1998.1	317690	404496	257259456	25.2190	8.5997	2.80346	1.57233
637	2001.2	318690	405769	258474853	25.2389	8.6043	2.80414	1.56986
638	2004.3	319692	407044	259694072	25.2587	8.6088	2.80482	1.56740
639	2007.5	320695	408321	260917119	25.2784	8.6132	2.80550	1.56495
640	2010.6	321699	409600	262144000	25.2982	8.6177	2.80618	1.56250
641	2013.8	322705	410881	263374721	25.3180	8.6222	2.80686	1.56006
642	2016.9	323713	412164	264609288	25.3377	8.6267	2.80754	1.55763
643	2020.0	324722	413449	265847707	25.3574	8.6312	2.80821	1.55521
644	2023.2	325733	414736	267089984	25.3772	8.6357	2.80889	1.55280
645	2026.3	326745	416025	268336125	25.3969	8.6401	2.80956	1.55039
646	2029.5	327759	417316	269586136	25.4165	8.6446	2.81023	1.54799
647	2032.6	328775	418609	270840023	25.4362	8.6490	2.81090	1.54560
648	2035.8	329792	419904	272097792	25.4558	8.6535	2.81158	1.54321
649	2038.9	330810	421201	273359449	25.4755	8.6579	2.81224	1.54083

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	*No. = Diam.*		*Square.*	*Cube.*	*Square Root.*	*Cube Root.*	*Log.*	*1000 × Recip.*
	Circum.	*Area.*						
650	2042.0	331831	422500	274625000	25.4951	8.6624	2.81291	1.53846
651	2045.2	332853	423801	275894451	25.5147	8.6668	2.81358	1.53610
652	2048.3	333876	425104	277167808	25.5343	8.6713	2.81425	1.53374
653	2051.5	334901	426409	278445077	25.5539	8.6757	2.81491	1.53139
654	2054.6	335927	427716	279726264	25.5734	8.6801	2.81558	1.52905
655	2057.7	336955	429025	281011375	25.5930	8.6845	2.81624	1.52672
656	2060.9	337985	430336	282300416	25.6125	8.6890	2.81690	1.52439
657	2064.0	339016	431649	283593393	25.6320	8.6934	2.81757	1.52207
658	2067.2	340049	432964	284890312	25.6515	8.6978	2.81823	1.51976
659	2070.3	341084	434281	286191179	25.6710	8.7022	2.81889	1.51745
660	2073.5	342119	435600	287496000	25.6905	8.7066	2.81954	1.51515
661	2076.6	343157	436921	288804781	25.7099	8.7110	2.82020	1.51286
662	2079.7	344196	438244	290117528	25.7294	8.7154	2.82086	1.51057
663	2082.9	345237	439569	291434247	25.7488	8.7198	2.82151	1.50830
664	2086.0	346279	440896	292754944	25.7682	8.7241	2.82217	1.50602
665	2089.2	347323	442225	294079625	25.7876	8.7285	2.82282	1.50376
666	2092.3	348368	443556	295408296	25.8070	8.7329	2.82347	1.50150
667	2095.4	349415	444889	296740963	25.8263	8.7373	2.82413	1.49925
668	2098.6	350464	446224	298077632	25.8457	8.7416	2.82478	1.49701
669	2101.7	351514	447561	299418309	25.8650	8.7460	2.82543	1.49477
670	2104.9	352565	448900	300763000	25.8844	8.7503	2.82607	1.49254
671	2108.0	353618	450241	302111711	25.9037	8.7547	2.82672	1.49031
672	2111.2	354673	451584	303464448	25.9230	8.7590	2.82737	1.48810
673	2114.3	355730	452929	304821217	25.9422	8.7634	2.82802	1.48588
674	2117.4	356788	454276	306182024	25.9615	8.7677	2.82866	1.48368
675	2120.6	357847	455625	307546875	25.9808	8.7721	2.82930	1.48148
676	2123.7	358908	456976	308915776	26.0000	8.7764	2.82995	1.47929
677	2126.9	359971	458329	310288733	26.0192	8.7807	2.83059	1.47711
678	2130.0	361035	459684	311665752	26.0384	8.7850	2.83123	1.47493
679	2133.1	362101	461041	313046839	26.0576	8.7893	2.83187	1.47275
680	2136.3	363168	462400	314432000	26.0768	8.7937	2.83251	1.47059
681	2139.4	364237	463761	315821241	26.0960	8.7980	2.83315	1.46843
682	2142.6	365308	465124	317214568	26.1151	8.8023	2.83378	1.46628
683	2145.7	366380	466489	318611987	26.1343	8.8066	2.83442	1.46413
684	2148.9	367453	467856	320013504	26.1534	8.8109	2.83506	1.46199
685	2152.0	368528	469225	321419125	26.1725	8.8152	2.83569	1.45985
686	2155.1	369605	470596	322828856	26.1916	8.8194	2.83632	1.45773
687	2158.3	370684	471969	324242703	26.2107	8.8237	2.83696	1.45560
688	2161.4	371764	473344	325660672	26.2298	8.8280	2.83759	1.45349
689	2164.6	372845	474721	327082769	26.2488	8.8323	2.83822	1.45138
690	2167.7	373928	476100	328509000	26.2679	8.8366	2.83885	1.44928
691	2170.8	375013	477481	329939371	26.2869	8.8408	2.83948	1.44718
692	2174.0	376099	478864	331373888	26.3059	8.8451	2.84011	1.44509
693	2177.1	377187	480249	332812557	26.3249	8.8493	2.84073	1.44300
694	2180.3	378276	481636	334255384	26.3439	8.8536	2.84136	1.44092
695	2183.4	379367	483025	335702375	26.3629	8.8578	2.84198	1.43885
696	2186.6	380459	484416	337153536	26.3818	8.8621	2.84261	1.43678
697	2189.7	381554	485809	338608873	26.4008	8.8663	2.84323	1.43472
698	2192.8	382649	487204	340068392	26.4197	8.8706	2.84386	1.43267
699	2196.0	383746	488601	341532099	26.4386	8.8748	2.84448	1.43062

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam. Circum.	No. = Diam. Area.	Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
700	2199.1	384845	490000	343000000	26.4575	8.8790	2.84510	1.42857
701	2202.3	385945	491401	344472101	26.4764	8.8833	2.84572	1.42653
702	2205.4	387047	492804	345948408	26.4953	8.8875	2.84634	1.42450
703	2208.5	388151	494209	347428927	26.5141	8.8917	2.84696	1.42248
704	2211.7	389256	495616	348913664	26.5330	8.8959	2.84757	1.42046
705	2214.8	390363	497025	350402625	26.5518	8.9001	2.84819	1.41844
706	2218.0	391471	498436	351895816	26.5707	8.9043	2.84880	1.41643
707	2221.1	392580	499849	353393243	26.5895	8.9085	2.84942	1.41443
708	2224.3	393692	501264	354894912	26.6083	8.9127	2.85003	1.41243
709	2227.4	394805	502681	356400829	26.6271	8.9169	2.85065	1.41044
710	2230.5	395919	504100	357911000	26.6458	8.9211	2.85126	1.40845
711	2233.7	397035	505521	359425431	26.6646	8.9253	2.85187	1.40647
712	2236.8	398153	506944	360944128	26.6833	8.9295	2.85248	1.40449
713	2240.0	399272	508369	362467097	26.7021	8.9337	2.85309	1.40253
714	2243.1	400393	509796	363994344	26.7208	8.9378	2.85370	1.40056
715	2246.2	401515	511225	365525875	26.7395	8.9420	2.85431	1.39860
716	2249.4	402639	512656	367061696	26.7582	8.9462	2.85491	1.39665
717	2252.5	403765	514089	368601813	26.7769	8.9503	2.85552	1.39470
718	2255.7	404892	515524	370146232	26.7955	8.9545	2.85612	1.39276
719	2258.8	406020	516961	371694959	26.8142	8.9587	2.85673	1.39082
720	2261.9	407150	518400	373248000	26.8328	8.9628	2.85733	1.38889
721	2265.1	408282	519841	374805361	26.8514	8.9670	2.85794	1.38696
722	2268.2	409416	521284	376367048	26.8701	8.9711	2.85854	1.38504
723	2271.4	410550	522729	377933067	26.8887	8.9752	2.85914	1.38313
724	2274.5	411687	524176	379503424	26.9072	8.9794	2.85974	1.38122
725	2277.7	412825	525625	381078125	26.9258	8.9835	2.86034	1.37931
726	2280.8	413965	527076	382657176	26.9444	8.9876	2.86094	1.37741
727	2283.9	415106	528529	384240583	26.9629	8.9918	2.86153	1.37552
728	2287.1	416248	529984	385828352	26.9815	8.9959	2.86213	1.37363
729	2290.2	417393	531441	387420489	27.0000	9.0000	2.86273	1.37174
730	2293.4	418539	532900	389017000	27.0185	9.0041	2.86332	1.36986
731	2296.5	419686	534361	390617891	27.0370	9.0082	2.86392	1.36799
732	2299.7	420835	535824	392223168	27.0555	9.0123	2.86451	1.36612
733	2302.8	421986	537289	393832837	27.0740	9.0164	2.86510	1.36426
734	2305.9	423138	538756	395446904	27.0924	9.0205	2.86570	1.36240
735	2309.1	424293	540225	397065375	27.1109	9.0246	2.86629	1.36054
736	2312.2	425448	541696	398688256	27.1293	9.0287	2.86688	1.35870
737	2315.4	426604	543169	400315553	27.1477	9.0328	2.86747	1.35685
738	2318.5	427762	544644	401947272	27.1662	9.0369	2.86806	1.35501
739	2321.6	428922	546121	403583419	27.1846	9.0410	2.86864	1.35318
740	2324.8	430084	547600	405224000	27.2029	9.0450	2.86923	1.35135
741	2327.9	431247	549081	406869021	27.2213	9.0491	2.86982	1.34953
742	2331.1	432412	550564	408518488	27.2397	9.0532	2.87040	1.34771
743	2334.2	433578	552049	410172407	27.2580	9.0572	2.87099	1.34590
744	2337.3	434746	553536	411830784	27.2764	9.0613	2.87157	1.34409
745	2340.5	435916	555025	413493625	27.2947	9.0654	2.87216	1.34228
746	2343.6	437087	556516	415160936	27.3130	9.0694	2.87274	1.34048
747	2346.8	438259	558009	416832723	27.3313	9.0735	2.87332	1.33869
748	2349.9	439433	559504	418508992	27.3496	9.0775	2.87390	1.33690
749	2353.1	440609	561001	420189749	27.3679	9.0816	2.87448	1.33511

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
750	2356.2	441786	562500	421875000	27.3861	9.0856	2.87506	1.33383
751	2359.3	442965	564001	423564751	27.4044	9.0896	2.87564	1.33156
752	2362.5	444146	565504	425259008	27.4226	9.0937	2.87622	1.32979
753	2365.6	445328	567009	426957777	27.4408	9.0977	2.87679	1.32802
754	2368.8	446511	568516	428661064	27.4591	9.1017	2.87737	1.32626
755	2371.9	447697	570025	430368875	27.4773	9.1057	2.87795	1.32450
756	2375.0	448883	571536	432081216	27.4955	9.1098	2.87852	1.32275
757	2378.2	450072	573049	433798093	27.5136	9.1138	2.87910	1.32100
758	2381.3	451262	574564	435519512	27.5318	9.1178	2.87967	1.31926
759	2384.5	452453	576081	437245479	27.5500	9.1218	2.88024	1.31752
760	2387.6	453646	577600	438976000	27.5681	9.1258	2.88081	1.31579
761	2390.8	454841	579121	440711081	27.5862	9.1298	2.88138	1.31406
762	2393.9	456037	580644	442450728	27.6043	9.1338	2.88195	1.31234
763	2397.0	457234	582169	444194947	27.6225	9.1378	2.88252	1.31062
764	2400.2	458434	583696	445943744	27.6405	9.1418	2.88309	1.30890
765	2403.3	459635	585225	447697125	27.6586	9.1458	2.88366	1.30719
766	2406.5	460837	586756	449455096	27.6767	9.1498	2.88423	1.30548
767	2409.6	462042	588289	451217663	27.6948	9.1537	2.88480	1.30378
768	2412.7	463247	589824	452984832	27.7128	9.1577	2.88536	1.30208
769	2415.9	464454	591361	454756609	27.7308	9.1617	2.88593	1.30039
770	2419.0	465663	592900	456533000	27.7489	9.1657	2.88649	1.29870
771	2422.2	466873	594441	458314011	27.7669	9.1696	2.88705	1.29702
772	2425.3	468085	595984	460099648	27.7849	9.1736	2.88762	1.29534
773	2428.5	469298	597529	461889917	27.8029	9.1775	2.88818	1.29366
774	2431.6	470513	599076	463684824	27.8209	9.1815	2.88874	1.29199
775	2434.7	471730	600625	465484375	27.8388	9.1855	2.88930	1.29032
776	2437.9	472948	602176	467288576	27.8568	9.1894	2.88986	1.28866
777	2441.0	474168	603729	469097433	27.8747	9.1933	2.89042	1.28700
778	2444.2	475389	605284	470910952	27.8927	9.1973	2.89098	1.28535
779	2447.3	476612	606841	472729139	27.9106	9.2012	2.89154	1.28370
780	2450.4	477836	608400	474552000	27.9285	9.2052	2.89209	1.28205
781	2453.6	479062	609961	476379541	27.9464	9.2091	2.89265	1.28041
782	2456.7	480290	611524	478211768	27.9643	9.2130	2.89321	1.27877
783	2459.9	481519	613089	480048687	27.9821	9.2170	2.89376	1.27714
784	2463.0	482750	614656	481890304	28.0000	9.2209	2.89432	1.27551
785	2466.2	483982	616225	483736625	28.0179	9.2248	2.89487	1.27389
786	2469.3	485216	617796	485587656	28.0357	9.2287	2.89542	1.27226
787	2472.4	486451	619369	487443403	28.0535	9.2326	2.89597	1.27065
788	2475.6	487688	620944	489303872	28.0713	9.2365	2.89653	1.26904
789	2478.7	488927	622521	491169069	28.0891	9.2404	2.89708	1.26743
790	2481.9	490167	624100	493039000	28.1069	9.2443	2.89763	1.26582
791	2485.0	491409	625681	494913671	28.1247	9.2482	2.89818	1.26422
792	2488.1	492652	627264	496793088	28.1425	9.2521	2.89873	1.26263
793	2491.3	493897	628849	498677257	28.1603	9.2560	2.89927	1.26103
794	2494.4	495143	630436	500566184	28.1780	9.2599	2.89982	1.25945
795	2497.6	496391	632025	502459875	28.1957	9.2638	2.90037	1.25786
796	2500.7	497641	633616	504358336	28.2135	9.2677	2.90091	1.25628
797	2503.8	498892	635209	506261573	28.2312	9.2716	2.90146	1.25471
798	2507.0	500145	636804	508169592	28.2489	9.2754	2.90200	1.25313
799	2510.1	501399	638401	510082399	28.2666	9.2793	2.90255	1.25156

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
800	2513.3	502655	640000	512000000	28.2843	9.2832	2.90309	1.25000
801	2516.4	503912	641601	513922401	28.3019	9.2870	2.90363	1.24844
802	2519.6	505171	643204	515849608	28.3196	9.2909	2.90417	1.24688
803	2522.7	506432	644809	517781627	28.3373	9.2948	2.90472	1.24533
804	2525.8	507694	646416	519718464	28.3549	9.2986	2.90526	1.24378
805	2529.0	508958	648025	521660125	28.3725	9.3025	2.90580	1.24224
806	2532.1	510223	649636	523606616	28.3901	9.3063	2.90634	1.24069
807	2535.3	511490	651249	525557943	28.4077	9.3102	2.90687	1.23916
808	2538.4	512758	652864	527514112	28.4253	9.3140	2.90741	1.23762
809	2541.5	514028	654481	529475129	28.4429	9.3179	2.90795	1.23609
810	2544.7	515300	656100	531441000	28.4605	9.3217	2.90849	1.23457
811	2547.8	516573	657721	533411731	28.4781	9.3255	2.90902	1.23305
812	2551.0	517848	659344	535387328	28.4956	9.3294	2.90956	1.23153
813	2554.1	519124	660969	537367797	28.5132	9.3332	2.91009	1.23001
814	2557.3	520402	662596	539353144	28.5307	9.3370	2.91062	1.22850
815	2560.4	521681	664225	541343375	28.5482	9.3408	2.91116	1.22699
816	2563.5	522962	665856	543338496	28.5657	9.3447	2.91169	1.22549
817	2566.7	524245	667489	545338513	28.5832	9.3485	2.91222	1.22399
818	2569.8	525529	669124	547343432	28.6007	9.3523	2.91275	1.22249
819	2573.0	526814	670761	549353259	28.6182	9.3561	2.91328	1.22100
820	2576.1	528102	672400	551368000	28.6356	9.3599	2.91381	1.21951
821	2579.2	529391	674041	553387661	28.6531	9.3637	2.91434	1.21803
822	2582.4	530681	675684	555412248	28.6705	9.3675	2.91487	1.21655
823	2585.5	531973	677329	557441767	28.6880	9.3713	2.91540	1.21507
824	2588.7	533267	678976	559476224	28.7054	9.3751	2.91593	1.21359
825	2591.8	534562	680625	561515625	28.7228	9.3789	2.91645	1.21212
826	2595.0	535858	682276	563559976	28.7402	9.3827	2.91698	1.21065
827	2598.1	537157	683929	565609283	28.7576	9.3865	2.91751	1.20919
828	2601.2	538456	685584	567663552	28.7750	9.3902	2.91803	1.20773
829	2604.4	539758	687241	569722789	28.7924	9.3940	2.91855	1.20627
830	2607.5	541061	688900	571787000	28.8097	9.3978	2.91908	1.20482
831	2610.7	542365	690561	573856191	28.8271	9.4016	2.91960	1.20337
832	2613.8	543671	692224	575930368	28.8444	9.4053	2.92012	1.20192
833	2616.9	544979	693889	578009537	28.8617	9.4091	2.92065	1.20048
834	2620.1	546288	695556	580093704	28.8791	9.4129	2.92117	1.19904
835	2623.2	547599	697225	582182875	28.8964	9.4166	2.92169	1.19760
836	2626.4	548912	698896	584277056	28.9137	9.4204	2.92221	1.19617
837	2629.5	550226	700569	586376253	28.9310	9.4241	2.92273	1.19474
838	2632.7	551541	702244	588480472	28.9482	9.4279	2.92324	1.19332
839	2635.8	552858	703921	590589719	28.9655	9.4316	2.92376	1.19189
840	2638.9	554177	705600	592704000	28.9828	9.4354	2.92428	1.19048
841	2642.1	555497	707281	594823321	29.0000	9.4391	2.92480	1.18906
842	2645.2	556819	708964	596947688	29.0172	9.4429	2.92531	1.18765
843	2648.4	558142	710649	599077107	29.0345	9.4466	2.92583	1.18624
844	2651.5	559467	712336	601211584	29.0517	9.4503	2.92634	1.18483
845	2654.6	560794	714025	603351125	29.0689	9.4541	2.92686	1.18343
846	2657.8	562122	715716	605495736	29.0861	9.4578	2.92737	1.18203
847	2660.9	563452	717409	607645423	29.1033	9.4615	2.92788	1.18064
848	2664.1	564783	719104	609800192	29.1204	9.4652	2.92840	1.17925
849	2667.2	566116	720801	611960049	29.1376	9.4690	2.92891	1.17786

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
850	2670.4	567450	722500	614125000	29.1548	9.4727	2.92942	1.17647
851	2673.5	568786	724201	616295051	29.1719	9.4764	2.92993	1.17509
852	2676.6	570124	725904	618470208	29.1890	9.4801	2.93044	1.17371
853	2679.8	571463	727609	620650477	29.2062	9.4838	2.93095	1.17233
854	2682.9	572803	729316	622835864	29.2233	9.4875	2.93146	1.17096
855	2686.1	574146	731025	625026375	29.2404	9.4912	2.93197	1.16959
856	2689.2	575490	732736	627222016	29.2575	9.4949	2.93247	1.16822
857	2692.3	576835	734449	629422793	29.2746	9.4986	2.93298	1.16686
858	2695.5	578182	736164	631628712	29.2916	9.5023	2.93349	1.16550
859	2698.6	579530	737881	633839779	29.3087	9.5060	2.93399	1.16414
860	2701.8	580880	739600	636056000	29.3258	9.5097	2.93450	1.16279
861	2704.9	582232	741321	638277381	29.3428	9.5134	2.93500	1.16144
862	2708.1	583585	743044	640503928	29.3598	9.5171	2.93551	1.16009
863	2711.2	584940	744769	642735647	29.3769	9.5207	2.93601	1.15875
864	2714.3	586297	746496	644972544	29.3939	9.5244	2.93651	1.15741
865	2717.5	587655	748225	647214625	29.4109	9.5281	2.93702	1.15607
866	2720.6	589014	749956	649461896	29.4279	9.5317	2.93752	1.15473
867	2723.8	590375	751689	651714363	29.4449	9.5354	2.93802	1.15340
868	2726.9	591738	753424	653972032	29.4618	9.5391	2.93852	1.15207
869	2730.0	593102	755161	656234909	29.4788	9.5427	2.93902	1.15075
870	2733.2	594468	756900	658503000	29.4958	9.5464	2.93952	1.14943
871	2736.3	595835	758641	660776311	29.5127	9.5501	2.94002	1.14811
872	2739.5	597204	760384	663054848	29.5296	9.5537	2.94052	1.14679
873	2742.6	598575	762129	665338617	29.5466	9.5574	2.94101	1.14548
874	2745.8	599947	763876	667627624	29.5635	9.5610	2.94151	1.14416
875	2748.9	601320	765625	669921875	29.5804	9.5647	2.94201	1.14286
876	2752.0	602696	767376	672221376	29.5973	9.5683	2.94250	1.14155
877	2755.2	604073	769129	674526133	29.6142	9.5719	2.94300	1.14025
878	2758.3	605451	770884	676836152	29.6311	9.5756	2.94349	1.13895
879	2761.5	606831	772641	679151439	29.6479	9.5792	2.94399	1.13766
880	2764.6	608212	774400	681472000	29.6648	9.5828	2.94448	1.13636
881	2767.7	609595	776161	683797841	29.6816	9.5865	2.94498	1.13507
882	2770.9	610980	777924	686128968	29.6985	9.5901	2.94547	1.13379
883	2774.0	612366	779689	688465387	29.7153	9.5937	2.94596	1.13250
884	2777.2	613754	781456	690807104	29.7321	9.5973	2.94645	1.13122
885	2780.3	615143	783225	693154125	29.7489	9.6010	2.94694	1.12994
886	2783.5	616534	784996	695506456	29.7658	9.6046	2.94743	1.12867
887	2786.6	617927	786769	697864103	29.7825	9.6082	2.94792	1.12740
888	2789.7	619321	788544	700227072	29.7993	9.6118	2.94841	1.12613
889	2792.9	620717	790321	702595369	29.8161	9.6154	2.94890	1.12486
890	2796.0	622114	792100	704969000	29.8329	9.6190	2.94939	1.12360
891	2799.2	623513	793881	707347971	29.8496	9.6226	2.94988	1.12233
892	2802.3	624913	795664	709732288	29.8664	9.6262	2.95036	1.12108
893	2805.4	626315	797449	712121957	29.8831	9.6298	2.95085	1.11982
894	2808.6	627718	799236	714516984	29.8998	9.6334	2.95134	1.11857
895	2811.7	629124	801025	716917375	29.9166	9.6370	2.95182	1.11732
896	2814.9	630530	802816	719323136	29.9333	9.6406	2.95231	1.11607
897	2818.0	631938	804609	721734273	29.9500	9.6442	2.95279	1.11483
898	2821.2	633348	806404	724150792	29.9666	9.6477	2.95328	1.11359
899	2824.3	634760	808201	726572699	29.9833	9.6513	2.95376	1.11235

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	*No. = Diam.*		*Square.*	*Cube.*	*Square Root.*	*Cube Root.*	*Log.*	*1000 × Recip.*
	Circum.	*Area.*						
900	2827.4	636173	810000	729000000	30.0000	9.6549	2.95424	1.11111
901	2830.6	637587	811801	731432701	30.0167	9.6585	2.95472	1.10988
902	2833.7	639003	813604	733870808	30.0333	9.6620	2.95521	1.10865
903	2836.9	640421	815409	736314327	30.0500	9.6656	2.95569	1.10742
904	2840.0	641840	817216	738763264	30.0666	9.6692	2.95617	1.10619
905	2843.1	643261	819025	741217625	30.0832	9.6727	2.95665	1.10497
906	2846.3	644683	820836	743677416	30.0998	9.6763	2.95713	1.10375
907	2849.4	646107	822649	746142643	30.1164	9.6799	2.95761	1.10254
908	2852.6	647533	824464	748613312	30.1330	9.6834	2.95809	1.10132
909	2855.7	648960	826281	751089429	30.1496	9.6870	2.95856	1.10011
910	2858.8	650388	828100	753571000	30.1662	9.6905	2.95904	1.09890
911	2862.0	651818	829921	756058031	30.1828	9.6941	2.95952	1.09769
912	2865.1	653250	831744	758550528	30.1993	9.6976	2.95999	1.09649
913	2868.3	654684	833569	761048497	30.2159	9.7012	2.96047	1.09529
914	2871.4	656118	835396	763551944	30.2324	9.7047	2.96095	1.09409
915	2874.6	657555	837225	766060875	30.2490	9.7082	2.96142	1.09290
916	2877.7	658993	839056	768575296	30.2655	9.7118	2.96190	1.09170
917	2880.8	660433	840889	771095213	30.2820	9.7153	2.96237	1.09051
918	2884.0	661874	842724	773620632	30.2985	9.7188	2.96284	1.08932
919	2887.1	663317	844561	776151559	30.3150	9.7224	2.96332	1.08814
920	2890.3	664761	846400	778688000	30.3315	9.7259	2.96379	1.08696
921	2893.4	666207	848241	781229961	30.3480	9.7294	2.96426	1.08578
922	2896.5	667654	850084	783777448	30.3645	9.7329	2.96473	1.08460
923	2899.7	669103	851929	786330467	30.3809	9.7364	2.96520	1.08342
924	2902.8	670554	853776	788889024	30.3974	9.7400	2.96567	1.08225
925	2906.0	672006	855625	791453125	30.4138	9.7435	2.96614	1.08108
926	2909.1	673460	857476	794022776	30.4302	9.7470	2.96661	1.07991
927	2912.3	674915	859329	796597983	30.4467	9.7505	2.96708	1.07875
928	2915.4	676372	861184	799178752	30.4631	9.7540	2.96755	1.07759
929	2918.5	677831	863041	801765089	30.4795	9.7575	2.96802	1.07643
930	2921.7	679291	864900	804357000	30.4959	9.7610	2.96848	1.07527
931	2924.8	680752	866761	806954491	30.5123	9.7645	2.96895	1.07411
932	2928.0	682216	868624	809557568	30.5287	9.7680	2.96942	1.07296
933	2931.1	683680	870489	812166237	30.5450	9.7715	2.96988	1.07181
934	2934.2	685147	872356	814780504	30.5614	9.7750	2.97035	1.07066
935	2937.4	686615	874225	817400375	30.5778	9.7785	2.97081	1.06952
936	2940.5	688084	876096	820025856	30.5941	9.7819	2.97128	1.06838
937	2943.7	689555	877969	822656953	30.6105	9.7854	2.97174	1.06724
938	2946.8	691028	879844	825293672	30.6268	9.7889	2.97220	1.06610
939	2950.0	692502	881721	827936019	30.6431	9.7924	2.97267	1.06496
940	2953.1	693978	883600	830584000	30.6594	9.7959	2.97313	1.06383
941	2956.2	695455	885481	833237621	30.6757	9.7993	2.97359	1.06270
942	2959.4	696934	887364	835896888	30.6920	9.8028	2.97405	1.06157
943	2962.5	698415	889249	838561807	30.7083	9.8063	2.97451	1.06045
944	2965.7	699897	891136	841232384	30.7246	9.8097	2.97497	1.05932
945	2968.8	701380	893025	843908625	30.7409	9.8132	2.97543	1.05820
946	2971.9	702865	894916	846590536	30.7571	9.8167	2.97589	1.05708
947	2975.1	704352	896809	849278123	30.7734	9.8201	2.97635	1.05597
948	2978.2	705840	898704	851971392	30.7896	9.8236	2.97681	1.05485
949	2981.4	707330	900601	854670349	30.8058	9.8270	2.97727	1.05374

CIRCUMFERENCES, CIRCULAR AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 TO 1000.

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
950	2984.5	708822	902500	857375000	30.8221	9.8305	2.97772	1.05263
951	2987.7	710315	904401	860085351	30.8383	9.8339	2.97818	1.05152
952	2990.8	711809	906304	862801408	30.8545	9.8374	2.97864	1.05042
953	2993.9	713306	908209	865523177	30.8707	9.8408	2.97909	1.04932
954	2997.1	714803	910116	868250664	30.8869	9.8443	2.97955	1.04822
955	3000.2	716303	912025	870983875	30.9031	9.8477	2.98000	1.04712
956	3003.4	717804	913936	873722816	30.9192	9.8511	2.98046	1.04603
957	3006.5	719306	915849	876467493	30.9354	9.8546	2.98091	1.04493
958	3009.6	720810	917764	879217912	30.9516	9.8580	2.98137	1.04384
959	3012.8	722316	919681	881974079	30.9677	9.8614	2.98182	1.04275
960	3015.9	723823	921600	884736000	30.9839	9.8648	2.98227	1.04167
961	3019.1	725332	923521	887503681	31.0000	9.8683	2.98272	1.04058
962	3022.2	726842	925444	890277128	31.0161	9.8717	2.98318	1.03950
963	3025.4	728354	927369	893056347	31.0322	9.8751	2.98363	1.03842
964	3028.5	729867	929296	895841344	31.0483	9.8785	2.98408	1.03734
965	3031.6	731382	931225	898632125	31.0644	9.8819	2.98453	1.03627
966	3034.8	732899	933156	901428696	31.0805	9.8854	2.98498	1.03520
967	3037.9	734417	935089	904231063	31.0966	9.8888	2.98543	1.03413
968	3041.1	735937	937024	907039232	31.1127	9.8922	2.98588	1.03306
969	3044.2	737458	938961	909853209	31.1288	9.8956	2.98632	1.03199
970	3047.3	738981	940900	912673000	31.1448	9.8990	2.98677	1.03093
971	3050.5	740506	942841	915498611	31.1609	9.9024	2.98722	1.02987
972	3053.6	742032	944784	918330048	31.1769	9.9058	2.98767	1.02881
973	3056.8	743559	946729	921167317	31.1929	9.9092	2.98811	1.02775
974	3059.9	745088	948676	924010424	31.2090	9.9126	2.98856	1.02669
975	3063.1	746619	950625	926859375	31.2250	9.9160	2.98900	1.02564
976	3066.2	748151	952576	929714176	31.2410	9.9194	2.98945	1.02459
977	3069.3	749685	954529	932574833	31.2570	9.9227	2.98989	1.02354
978	3072.5	751221	956484	935441352	31.2730	9.9261	2.99034	1.02249
979	3075.6	752758	958441	938313739	31.2890	9.9295	2.99078	1.02145
980	3078.8	754296	960400	941192000	31.3050	9.9329	2.99123	1.02041
981	3081.9	755837	962361	944076141	31.3209	9.9363	2.99167	1.01937
982	3085.0	757378	964324	946966168	31.3369	9.9396	2.99211	1.01833
983	3088.2	758922	966289	949862087	31.3528	9.9430	2.99255	1.01729
984	3091.3	760466	968256	952763904	31.3688	9.9464	2.99300	1.01626
985	3094.5	762013	970225	955671625	31.3847	9.9497	2.99344	1.01523
986	3097.6	763561	972196	958585256	31.4006	9.9531	2.99388	1.01420
987	3100.8	765111	974169	961504803	31.4166	9.9565	2.99432	1.01317
988	3103.9	766662	976144	964430272	31.4325	9.9598	2.99476	1.01215
989	3107.0	768214	978121	967361669	31.4484	9.9632	2.99520	1.01112
990	3110.2	769769	980100	970299000	31.4643	9.9666	2.99564	1.01010
991	3113.3	771325	982081	973242271	31.4802	9.9699	2.99607	1.00908
992	3116.5	772882	984064	976191488	31.4960	9.9733	2.99651	1.00806
993	3119.6	774441	986049	979146657	31.5119	9.9766	2.99695	1.00705
994	3122.7	776002	988036	982107784	31.5278	9.9800	2.99739	1.00604
995	3125.9	777564	990025	985074875	31.5436	9.9833	2.99782	1.00503
996	3129.0	779128	992016	988047936	31.5595	9.9866	2.99826	1.00402
997	3132.2	780693	994009	991026973	31.5753	9.9900	2.99870	1.00301
998	3135.3	782260	996004	994011992	31.5911	9.9933	2.99913	1.00200
999	3138.5	783828	998001	997002999	31.6070	9.9967	2.99957	1.00100

DECIMAL EQUIVALENTS FOR VULGAR FRACTIONS.

The given decimals are the parts of inches corresponding to fraction of inches in first column; also, the parts of feet for the fraction of inches in third column.

	.0052	1/16		.2552	3 1/16		.5052	6 1/16		.7552	9 1/16
	.0104	1/8		.2604	3 1/8		.5104	6 1/8		.7604	9 1/8
1/64	.015625	3/16	17/64	.265625	3 3/16	33/64	.515625	6 3/16	49/64	.765625	9 3/16
	.0208	1/4		.2708	3 1/4		.5208	6 1/4		.7708	9 1/4
	.0260	5/16		.2760	3 5/16		.5260	6 5/16		.7760	9 5/16
1/32	.03125	3/8	9/32	.28125	3 3/8	17/32	.53125	6 3/8	25/32	.78125	9 3/8
	.0364	7/16		.2865	3 7/16		.5364	6 7/16		.7865	9 7/16
	.0417	1/2		.2917	3 1/2		.5417	6 1/2		.7917	9 1/2
3/64	.046875	9/16	19/64	.296875	3 9/16	35/64	.546875	6 9/16	51/64	.796875	9 9/16
	.0521	5/8		.3021	3 5/8		.5521	6 5/8		.8021	9 5/8
	.0573	11/16		.3073	3 11/16		.5573	6 11/16		.8073	9 11/16
1/16	.0625	3/4	5/16	.3125	3 3/4	9/16	.5625	6 3/4	13/16	.8125	9 3/4
	.0677	13/16		.3177	3 13/16		.5677	6 13/16		.8177	9 13/16
	.0729	7/8		.3229	3 7/8		.5729	6 7/8		.8229	9 7/8
5/64	.078125	15/16	21/64	.328125	3 15/16	37/64	.578125	6 15/16	53/64	.828125	9 15/16
	.0833	1		.3333	4		.5833	7		.8333	10
	.0885	1 1/16		.3385	4 1/16		.5885	7 1/16		.8385	10 1/16
3/32	.09375	1 1/8	11/32	.34375	4 1/8	19/32	.59375	7 1/8	27/32	.84375	10 1/8
	.0990	1 3/16		.3490	4 3/16		.5990	7 3/16		.8490	10 3/16
	.1042	1 1/4		.3542	4 1/4		.6042	7 1/4		.8542	10 1/4
7/64	.109375	1 5/16	23/64	.359375	4 5/16	39/64	.609375	7 5/16	55/64	.859375	10 5/16
	.1146	1 3/8		.3646	4 3/8		.6146	7 3/8		.8646	10 3/8
	.1198	1 7/16		.3698	4 7/16		.6198	7 7/16		.8698	10 7/16
1/8	.1250	1 1/2	3/8	.3750	4 1/2	5/8	.6250	7 1/2	7/8	.8750	10 1/2
	.1302	1 9/16		.3802	4 9/16		.6302	7 9/16		.8802	10 9/16
	.1354	1 5/8		.3854	4 5/8		.6354	7 5/8		.8854	10 5/8
9/64	.140625	1 11/16	25/64	.390625	4 11/16	41/64	.640625	7 11/16	57/64	.890625	10 11/16
	.1458	1 3/4		.3958	4 3/4		.6458	7 3/4		.8958	10 3/4
	.1510	1 13/16		.4010	4 13/16		.6510	7 13/16		.9010	10 13/16
5/32	.15625	1 7/8	13/32	.40625	4 7/8	21/32	.65625	7 7/8	29/32	.90625	10 7/8
	.1615	1 15/16		.4114	4 15/16		.6615	7 15/16		.9115	10 15/16
	.1667	2		.4167	5		.6667	8		.9167	11
11/64	.171875	2 1/16	27/64	.421875	5 1/16	43/64	.671875	8 1/16	59/64	.921875	11 1/16
	.1771	2 1/8		.4271	5 1/8		.6771	8 1/8		.9271	11 1/8
	.1823	2 3/16		.4323	5 3/16		.6823	8 3/16		.9323	11 3/16
3/16	.1875	2 1/4	7/16	.4375	5 1/4	11/16	.6875	8 1/4	15/16	.9375	11 1/4
	.1927	2 5/16		.4427	5 5/16		.6927	8 5/16		.9427	11 5/16
	.1979	2 3/8		.4479	5 3/8		.6979	8 3/8		.9479	11 3/8
13/64	.203125	2 7/16	29/64	.453125	5 7/16	45/64	.703125	8 7/16	61/64	.953125	11 7/16
	.2083	2 1/2		.4583	5 1/2		.7083	8 1/2		.9583	11 1/2
	.2135	2 9/16		.4635	5 9/16		.7135	8 9/16		.9635	11 9/16
7/32	.21875	2 5/8	15/32	.46875	5 5/8	23/32	.71875	8 5/8	31/32	.96875	11 5/8
	.2240	2 11/16		.4740	5 11/16		.7240	8 11/16		.9740	11 11/16
	.2292	2 3/4		.4792	5 3/4		.7292	8 3/4		.9792	11 3/4
15/64	.234375	2 13/16	31/64	.484375	5 13/16	47/64	.734375	8 13/16	63/64	.984375	11 13/16
	.2395	2 7/8		.4896	5 7/8		.7396	8 7/8		.9896	11 7/8
	.2448	2 15/16		.4948	5 15/16		.7448	8 15/16		.9948	11 15/16
1/4	.2500	3	1/2	.5000	6	3/4	.7500	9	1	1.0000	12

NATURAL TRIGONOMETRICAL FUNCTIONS.

Deg.	*Min.*	*Sine.*	*Vers. Cos.*	*Cosecant.*	*Tang.*	*Co-tang.*	*Secant.*	*Vers. Sin.*	*Co-sine.*	*Min.*	*Deg.*
0	0	.00000	1.0000	*Infin.*	.00000	*Infin.*	1.0000	.00000	1.0000		**90**
	10	.00291	.99709	343.77	.00291	343.77	1.0000	.00000	.99999	50	
	20	.00582	.99418	171.89	.00582	171.88	1.0000	.00002	.99998	40	
	30	.00873	.99127	114.59	.00873	114.59	1.0000	.00004	.99996	30	
	40	.01163	.98836	85.946	.01164	85.940	1.0001	.00007	.99993	20	
	50	.01454	.98546	68.757	.01454	68.750	1.0001	.00010	.99989	10	
1	0	.01745	.98255	57.299	.01745	57.290	1.0001	.00015	.99985		**89**
	10	.02036	.97964	49.114	.02036	49.104	1.0002	.00021	.99979	50	
	20	.02327	.97673	42.976	.02327	42.964	1.0003	.00027	.99973	40	
	30	.02618	.97382	38.201	.02618	38.188	1.0003	.00034	.99966	30	
	40	.02908	.97091	34.382	.02910	34.368	1.0004	.00042	.99958	20	
	50	.03199	.96801	31.257	.03201	31.241	1.0005	.00051	.99949	10	
2	0	.03490	.96510	28.654	.03492	28.636	1.0006	.00061	.99939		**88**
	10	.03781	.96219	26.450	.03783	26.432	1.0007	.00071	.99928	50	
	20	.04071	.95929	24.562	.04075	24.542	1.0008	.00083	.99917	40	
	30	.04362	.95638	22.925	.04366	22.904	1.0009	.00095	.99905	30	
	40	.04652	.95347	21.494	.04657	21.470	1.0011	.00108	.99892	20	
	50	.04943	.95057	20.230	.04949	20.205	1.0012	.00122	.99878	10	
3	0	.05234	.94766	19.107	.05241	19.081	1.0014	.00137	.99863		**87**
	10	.05524	.94476	18.103	.05532	18.075	1.0015	.00153	.99847	50	
	20	.05814	.94185	17.198	.05824	17.169	1.0017	.00169	.99831	40	
	30	.06105	.93895	16.380	.06116	16.350	1.0019	.00186	.99813	30	
	40	.06395	.93605	15.637	.06408	15.605	1.0020	.00205	.99795	20	
	50	.06685	.93314	14.958	.06700	14.924	1.0022	.00224	.99776	10	
4	0	.06976	.93024	14.335	.06993	14.301	1.0024	.00243	.99756		**86**
	10	.07266	.92734	13.763	.07285	13.727	1.0026	.00264	.99736	50	
	20	.07556	.92444	13.235	.07577	13.197	1.0029	.00286	.99714	40	
	30	.07846	.92154	12.745	.07870	12.706	1.0031	.00308	.99692	30	
	40	.08136	.91864	12.291	.08163	12.250	1.0033	.00331	.99668	20	
	50	.08426	.91574	11.868	.08456	11.826	1.0036	.00356	.99644	10	
5	0	.08715	.91284	11.474	.08749	11.430	1.0038	.00380	.99619		**85**
	10	.09005	.90995	11.104	.09042	11.059	1.0041	.00406	.99594	50	
	20	.09295	.90705	10.758	.09335	10.712	1.0043	.00433	.99567	40	
	30	.09584	.90415	10.433	.09629	10.385	1.0046	.00460	.99540	30	
	40	.09874	.90126	10.127	.09922	10.078	1.0049	.00489	.99511	20	
	50	.10163	.89836	9.8391	.10216	9.7882	1.0052	.00518	.99482	10	
6	0	.10453	.89547	9.5668	.10510	9.5144	1.0055	.00548	.99452		**84**
	10	.10742	.89258	9.3092	.10805	9.2553	1.0058	.00579	.99421	50	
	20	.11031	.88969	9.0651	.11099	9.0098	1.0061	.00110	.99390	40	
	30	.11320	.88680	8.8337	.11393	8.7769	1.0065	.00643	.99357	30	
	40	.11609	.88391	8.6138	.11688	8.5555	1.0068	.00676	.99324	20	
	50	.11898	.88102	8.4046	.11983	8.3449	1.0071	.00710	.99290	10	
7	0	.12187	.87813	8.2055	.12278	8.1443	1.0075	.00745	.99255		**83**
	10	.12476	.87524	8.0156	.12574	7.9530	1.0079	.00781	.99219	50	
	20	.12764	.87236	7.8344	.12869	7.7703	1.0082	.00818	.99182	40	
	30	.13053	.86947	7.6613	.13165	7.5957	1.0086	.00855	.99144	30	
	40	.13341	.86659	7.4957	.13461	7.4287	1.0090	.00894	.99106	20	
	50	.13629	.86371	7.3372	.13757	7.2687	1.0094	.00933	.99067	10	
8	0	.13917	.86083	7.1853	.14054	7.1154	1.0098	.00973	.99027		**82**
	10	.14205	.85795	7.0396	.14351	6.9682	1.0102	.01014	.98986	50	
	20	.14493	.85507	6.8998	.14648	6.8269	1.0107	.01056	.98944	40	
	30	.14781	.85219	6.7655	.14945	6.6911	1.0111	.01098	.98901	30	
	40	.15068	.84931	6.6363	.15243	6.5605	1.0115	.01142	.98858	20	
	50	.15356	.84644	6.5121	.15540	6.4348	1.0120	.01186	.98814	10	
9	0	.15643	.84356	6.3924	.15838	6.3137	1.0125	.01231	.98769		**81**
		Co-sine.	*Vers. Sin.*	*Secant.*	*Co-tang.*	*Tangent.*	*Cosecant.*	*Vers. Cos.*	*Sine.*		

NATURAL TRIGONOMETRICAL FUNCTIONS.

Deg.	Min.	Sine.	Vers. Cos.	Cose-cant.	Tang.	Co-tang.	Se-cant.	Vers. Sin.	Co-sine.	Min.	Deg.
9	0	.15643	.84356	6.3924	.15838	6.3137	1.0125	.01231	.98769		**81**
	10	.15931	.84069	6.2772	.16137	6.1970	1.0129	.01277	.98723	50	
	20	.16218	.83782	6.1661	.16435	6.0844	1.0134	.01324	.98676	40	
	30	.16505	.83495	6.0588	.16734	5.9758	1.0139	.01371	.98628	30	
	40	.16791	.83208	5.9554	.17033	5.8708	1.0144	.01420	.98580	20	
	50	.17078	.82922	5.8554	.17333	5.7694	1.0149	.01469	.98531	10	
10	0	.17365	.82635	5.7588	.17633	5.6713	1.0154	.01519	.98481		**80**
	10	.17651	.82349	5.6653	.17933	5.5764	1.0159	.01570	.98430	50	
	20	.17937	.82062	5.5749	.18233	5.4845	1.0165	.01622	.98378	40	
	30	.18223	.81776	5.4874	.18534	5.3955	1.0170	.01674	.98325	30	
	40	.18509	.81490	5.4026	.18835	5.3093	1.0176	.01728	.98272	20	
	50	.18795	.81205	5.3205	.19136	5.2257	1.0181	.01782	.98218	10	
11	0	.19081	.80919	5.2408	.19438	5.1445	1.0187	.01837	.98163		**79**
	10	.19366	.80634	5.1636	.19740	5.0658	1.0193	.01893	.98107	50	
	20	.19652	.80348	5.0886	.20042	4.9894	1.0199	.01950	.98050	40	
	30	.19937	.80063	5.0158	.20345	4.9151	1.0205	.02007	.97992	30	
	40	.20222	.79778	4.9452	.20648	4.8430	1.0211	.02066	.97934	20	
	50	.20506	.79493	4.8765	.20952	4.7728	1.0217	.02125	.97875	10	
12	0	.20791	.79209	4.8097	.21256	4.7046	1.0223	.02185	.97815		**78**
	10	.21076	.78924	4.7448	.21560	4.6382	1.0230	.02246	.97754	50	
	20	.21360	.78640	4.6817	.21864	4.5736	1.0236	.02308	.97692	40	
	30	.21644	.78356	4.6202	.22169	4.5107	1.0243	.02370	.97630	30	
	40	.21928	.78072	4.5604	.22475	4.4494	1·0249	.02434	.97566	20	
	50	.22211	.77788	4.5021	.22781	4.3897	1.0256	.02498	.97502	10	
13	0	.22495	.77505	4.4454	.23087	4.3315	1.0263	.02563	.97437		**77**
	10	.22778	.77221	4.3901	.23393	4.2747	1.0270	.02629	.97371	50	
	20	.23061	.76938	4.3362	.23700	4.2193	1.0277	.02695	.97304	40	
	30	.23344	.76655	4.2836	.24008	4.1653	1.0284	.02763	.97237	30	
	40	.23627	.76373	4.2324	.24316	4.1127	1.0291	.02831	.97169	20	
	50	.23910	.76090	4.1824	.24624	4.0611	1.0299	.02900	.97099	10	
14	0	.24192	.75808	4.1336	.24933	4.0108	1.0306	.02970	.97029		**76**
	10	.24474	.75526	4.0859	.25242	3.9616	1.0314	.03041	.96959	50	
	20	.24756	.75244	4.0394	.25552	3.9136	1.0321	.03113	.96887	40	
	30	.25038	.74962	3.9939	.25862	3.8667	1.0329	.03185	.96815	30	
	40	.25319	.74680	3.9495	.26172	3.8208	1.0337	.03258	.96741	20	
	50	.25601	.74399	3.9061	.26483	3.7759	1.0345	.03332	.96667	10	
15	0	.25882	.74118	3.8637	.26795	3.7320	1.0353	.03407	.96592		**75**
	10	.26163	.73837	3.8222	.27107	3.6891	1.0361	.03483	.96517	50	
	20	.26443	.73556	3.7816	.27419	3.6470	1.0369	.03560	.96440	40	
	30	.26724	.73276	3.7420	.27732	3.6059	1.0377	.03637	.96363	30	
	40	.27004	.72996	3.7031	.28046	3.5656	1.0386	.03715	.96285	20	
	50	.27284	.72716	3.6651	.28360	3.5261	1.0394	.03794	.96206	10	
16	0	.27564	.72436	3.6279	.28674	3.4874	1.0403	.03874	.96126		**74**
	10	.27843	.72157	3.5915	.28990	3.4495	1.0412	.03954	.96045	50	
	20	.28122	.71877	3.5559	.29305	3.4124	1.0420	.04036	.95964	40	
	30	.28401	.71608	3.5209	.29621	3.3759	1.0429	.04118	.95882	30	
	40	.28680	.71320	3.4867	.29938	3.3402	1.0438	.04201	.95799	20	
	50	.28959	.71041	3.4532	.30255	3.3052	1.0448	.04285	.95715	10	
17	0	.29237	.70763	3.4203	.30573	3.2708	1.0457	.04369	.95630		**73**
	10	.29515	.70485	3.3881	.30891	3.2371	1.0466	.04455	.95545	50	
	20	.29793	.70207	3.3565	.31210	3.2041	1.0476	.04541	.95459	40	
	30	.30070	.69929	3.3255	.31530	3.1716	1.0485	.04628	.95372	30	
	40	.30348	.69652	3.2951	.31850	3.1397	1.0495	.04716	.95284	20	
	50	.30625	.69375	3.2653	.32171	3.1084	1.0505	.04805	.95195	10	
18		.30902	.69098	3.2361	.32492	3.0777	1.0515	.04894	.95106		**72**
		Co-sine.	Vers. Sin.	Se-cant.	Co-tang.	Tan-gent.	Cose-cant.	Vers. Cos.	Sine.		

NATURAL TRIGONOMETRICAL FUNCTIONS.

Deg.	Min.	Sine.	Vers. Cos.	Cosecant.	Tang.	Co-tang.	Secant.	Vers. Sin.	Co-sine.	Min.	Deg.
18	0	.30902	.69098	3.2361	.32492	3.0777	1.0515	.04894	.95106		**72**
	10	.31178	.68822	3.2074	.32814	3.0475	1.0525	.04985	.95015	50	
	20	.31454	.68545	3.1792	.33136	3.0178	1.0535	.05076	.94924	40	
	30	.31730	.68269	3.1515	.33459	2.9887	1.0545	.05168	.94832	30	
	40	.32006	.67994	3.1244	.33783	2.9600	1.0555	.05260	.94740	20	
	50	.32282	.67718	3.0977	.34108	2.9319	1.0566	.05354	.94646	10	
19	0	.32557	.67443	3.0715	.34433	2.9042	1.0576	.05448	.94552		**71**
	10	.32832	.67168	3.0458	.34758	2.8770	1.0587	.05543	.94457	50	
	20	.33106	.66894	3.0206	.35085	2.8502	1.0598	.05639	.94361	40	
	30	.33381	.66619	2.9957	.35412	2.8239	1.0608	.05736	.94264	30	
	40	.33655	.66345	2.9713	.35739	2.7980	1.0619	.05833	.94167	20	
	50	.33928	.66071	2.9474	.36068	2.7725	1.0630	.05932	.94068	10	
20	0	.34202	.65798	2.9238	.36397	2.7475	1.0642	.06031	.93969		**70**
	10	.34475	.65525	2.9006	.36727	2.7228	1.0653	.06131	.93869	50	
	20	.34748	.65252	2.8778	.37057	2.6985	1.0664	.06231	.93769	40	
	30	.35021	.64979	2.8554	.37388	2.6746	1.0676	.06333	.93667	30	
	40	.35293	.64707	2.8334	.37720	2.6511	1.0688	.06435	.93565	20	
	50	.35565	.64435	2.8117	.38053	2.6279	1.0699	.06538	.93462	10	
21	0	.35837	.64163	2.7904	.38386	2.6051	1.0711	.06642	.93358		**69**
	10	.36108	.63892	2.7694	.38720	2.5826	1.0723	.06747	.93253	50	
	20	.36379	.63621	2.7488	.39055	2.5605	1.0736	.06852	.93148	40	
	30	.36650	.63350	2.7285	.39391	2.5386	1.0748	.06958	.93042	30	
	40	.36921	.63079	2.7085	.39727	2.5171	1.0760	.07065	.92935	20	
	50	.37191	.62809	2.6888	.40065	2.4960	1.0773	.07173	.92827	10	
22	0	.37461	.62539	2.6695	.40403	2.4751	1.0785	.07282	.92718		**68**
	10	.37730	.62270	2.6504	.40741	2.4545	1.0798	.07391	.92609	50	
	20	.37999	.62000	2.6316	.41081	2.4342	1.0811	.07501	.92499	40	
	30	.38268	.61732	2.6131	.41421	2.4142	1.0824	.07612	.92388	30	
	40	.38537	.61463	2.5949	.41762	2.3945	1.0837	.07724	.92276	20	
	50	.38805	.61195	2.5770	.42105	2.3750	1.0850	.07836	.92164	10	
23	0	.39073	.60927	2.5593	.42447	2.3558	1.0864	.07949	.92050		**67**
	10	.39341	.60659	2.5419	.42791	2.3369	1.0877	.08063	.91936	50	
	20	.39608	.60392	2.5247	.43136	2.3183	1.0891	.08178	.91822	40	
	30	.39875	.60125	2.5078	.43481	2.2998	1.0904	.08294	.91706	30	
	40	.40141	.59858	2.4912	.43827	2.2817	1.0918	.08410	.91590	20	
	50	.40408	.59592	2.4748	.44175	2.2637	1.0932	.08527	.91472	10	
24	0	.40674	.59326	2.4586	.44523	2.2460	1.0946	.08645	.91354		**66**
	10	.40939	.59061	2.4426	.44872	2.2286	1.0961	.08764	.91236	50	
	20	.41204	.58795	2.4269	.45222	2.2113	1.0975	.08884	.91116	40	
	30	.41469	.58531	2.4114	.45573	2.1943	1.0989	.09004	.90996	30	
	40	.41734	.58266	2.3961	.45924	2.1775	1.1004	.09125	.90875	20	
	50	.41998	.58002	2.3811	.46277	2.1609	1.1019	.09247	.90753	10	
25	0	.42262	.57738	2.3662	.46631	2.1445	1.1034	.09369	.90631		**65**
	10	.42525	.57475	2.3515	.46985	2.1283	1.1049	.09492	.90507	50	
	20	.42788	.57212	2.3371	.47341	2.1123	1.1064	.09617	.90383	40	
	30	.43051	.56949	2.3228	.47697	2.0965	1.1079	.09741	.90258	30	
	40	.43313	.56686	2.3087	.48055	2.0809	1.1095	.09867	.90133	20	
	50	.43575	.56424	2.2949	.48414	2.0655	1.1110	.09993	.90006	10	
26	0	.43837	.56163	2.2812	.48773	2.0503	1.1126	.10121	.89879		**64**
	10	.44098	.55902	2.2676	.49134	2.0352	1.1142	.10248	.89751	50	
	20	.44359	.55641	2.2543	.49495	2.0204	1.1158	.10377	.89623	40	
	30	.44620	.55380	2.2411	.49858	2.0057	1.1174	.10506	.89493	30	
	40	.44880	.55120	2.2282	.50222	1.9912	1.1190	.10637	.89363	20	
	50	.45140	.54860	2.2153	.50587	1.9768	1.1207	.10768	.89232	10	
27		.45399	.54601	2.2027	.50952	1.9626	1.1223	.10899	.89101		**63**
		Co-sine.	Vers. Sin.	Se-cant.	Co-tang.	Tan-gent.	Cose-cant.	Vers. Cos.	Sine.		

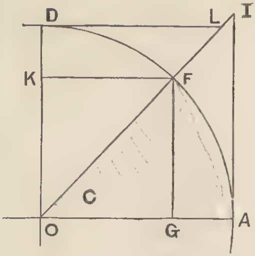
NATURAL TRIGONOMETRICAL FUNCTIONS.

Deg.	Min.	Sine.	Vers. Cos.	Cose-cant.	Tang.	Co-tang.	Se-cant.	Vers. Sin.	Co-sine.	Min.	Deg.
27	0	.45399	.54601	2.2027	.50952	1.9626	1.1223	.10899	.89101		**63**
	10	.45658	.54342	2.1902	.51319	1.9486	1.1240	.11032	.88968	50	
	20	.45917	.54083	2.1778	.51687	1.9347	1.1257	.11165	.88835	40	
	30	.46175	.53825	2.1657	.52057	1.9210	1.1274	.11299	.88701	30	
	40	.46433	.53567	2.1536	.52427	1.9074	1.1291	.11434	.88566	20	
	50	.46690	.53310	2.1418	.52798	1.8940	1.1308	.11569	.88431	10	
28	0	.46947	.53053	2.1300	.53171	1.8807	1.1326	.11705	.88295		**62**
	10	.47204	.52796	2.1185	.53545	1.8676	1.1343	.11842	.88158	50	
	20	.47460	.52540	2.1070	.53919	1.8546	1.1361	.11980	.88020	40	
	30	.47716	.52284	2.0957	.54295	1.8418	1.1379	.12118	.87882	30	
	40	.47971	.52029	2.0846	.54673	1.8291	1.1397	.12257	.87742	20	
	50	.48226	.51774	2.0735	.55051	1.8165	1.1415	.12397	.87603	10	
29	0	.48481	.51519	2.0627	.55431	1.8040	1.1433	.12538	.87462		**61**
	10	.48735	.51265	2.0519	.55812	1.7917	1.1452	.12679	.87320	50	
	20	.48989	.51011	2.0413	.56194	1.7795	1.1471	.12821	.87178	40	
	30	.49242	.50758	2.0308	.56577	1.7675	1.1489	.12964	.87035	30	
	40	.49495	.50505	2.0204	.56962	1.7555	1.1508	.13108	.86892	20	
	50	.49748	.50252	2.0101	.57348	1.7437	1.1528	.13252	.86748	10	
30	0	.50000	.50000	2.0000	.57735	1.7320	1.1547	.13397	.86602		**60**
	10	.50252	.49748	1.9900	.58123	1.7205	1.1566	.13543	.86457	50	
	20	.50503	.49497	1.9801	.58513	1.7090	1.1586	.13690	.86310	40	
	30	.50754	.49246	1.9703	.58904	1.6977	1.1606	.13837	.86163	30	
	40	.51004	.48996	1.9606	.59297	1.6864	1.1626	.13985	.86015	20	
	50	.51254	.48746	1.9510	.59691	1.6753	1.1646	.14134	.85866	10	
31	0	.51504	.48496	1.9416	.60086	1.6643	1.1666	.14283	.85717		**59**
	10	.51753	.48247	1.9322	.60483	1.6534	1.1687	.14433	.85566	50	
	20	.52002	.47998	1.9230	.60881	1.6425	1.1707	.14584	.85416	40	
	30	.52250	.47750	1.9139	.61280	1.6318	1.1728	.14736	.85264	30	
	40	.52498	.47502	1.9048	.61681	1.6212	1.1749	.14888	.85112	20	
	50	.52745	.47255	1.8959	.62083	1.6107	1.1770	.15041	.84959	10	
32	0	.52992	.47008	1.8871	.62487	1.6003	1.1792	.15195	.84805		**58**
	10	.53238	.46762	1.8783	.62892	1.5900	1.1813	.15350	.84650	50	
	20	.53484	.46516	1.8697	.63299	1.5798	1.1835	.15505	.84495	40	
	30	.53730	.46270	1.8611	.63707	1.5697	1.1857	.15661	.84339	30	
	40	.53975	.46025	1.8527	.64117	1.5596	1.1879	.15817	.84182	20	
	50	.54220	.45780	1.8443	.64528	1.5497	1.1901	.15975	.84025	10	
33	0	.54464	.45536	1.8361	.64941	1.5399	1.1924	.16133	.83867		**57**
	10	.54708	.45292	1.8279	.65355	1.5301	1.1946	.16292	.83708	50	
	20	.54951	.45049	1.8198	.65771	1.5204	1.1969	.16451	.83549	40	
	30	.55194	.44806	1.8118	.66188	1.5108	1.1992	.16611	.83388	30	
	40	.55436	.44564	1.8039	.66608	1.5013	1.2015	.16772	.83228	20	
	50	.55678	.44322	1.7960	.67028	1.4919	1.2039	.16934	.83066	10	
34	0	.55919	.44081	1.7883	.67451	1.4826	1.2062	.17096	.82904		**56**
	10	.56160	.43840	1.7806	.67875	1.4733	1.2086	.17259	.82741	50	
	20	.56401	.43599	1.7730	.68301	1.4641	1.2110	.17423	.82577	40	
	30	.56641	.43359	1.7655	.68728	1.4550	1.2134	.17587	.82413	30	
	40	.56880	.43120	1.7581	.69157	1.4460	1.2158	.17752	.82247	20	
	50	.57119	.42881	1.7507	.69588	1.4370	1.2183	.17918	.82082	10	
35	0	.57358	.42642	1.7434	.70021	1.4281	1.2208	.18085	.81915		**55**
	10	.57596	.42404	1.7362	.70455	1.4193	1.2233	.18252	.81748	50	
	20	.57833	.42167	1.7291	.70891	1.4106	1.2258	.18420	.81580	40	
	30	.58070	.41930	1.7220	.71329	1.4019	1.2283	.18588	.81411	30	
	40	.58307	.41693	1.7151	.71769	1.3933	1.2309	.18758	.81242	20	
	50	.58543	.41457	1.7081	.72211	1.3848	1.2335	.18928	.81072	10	
36	0	.58778	.41221	1.7013	.72654	1.3764	1.2361	.19098	.80902		**54**
		Co-sine.	*Vers. Sin.*	*Se-cant.*	*Co-tang.*	*Tan-gent.*	*Cose-cant.*	*Vers. Cos.*	*Sine.*		

NATURAL TRIGONOMETRICAL FUNCTIONS.

Deg.	*Min.*	*Sine.*	*Vers. Cos.*	*Cose-cant.*	*Tang.*	*Co-tang.*	*Se-cant.*	*Vers. Sin.*	*Co-sine.*	*Min.*	*Deg.*
36	0	.58778	.41221	1.7013	.72654	1.3764	1.2361	.19098	.80902		**54**
	10	.59014	.40986	1.6945	.73100	1.3680	1.2387	.19270	.80730	50	
	20	.59248	.40752	1.6878	.73547	1.3597	1.2413	.19442	.80558	40	
	30	.59482	.40518	1.6812	.73996	1.3514	1.2440	.19614	.80386	30	
	40	.59716	.40284	1.6746	.74447	1.3432	1.2467	.19788	.80212	20	
	50	.59949	.40051	1.6681	.74900	1.3351	1.2494	.19962	.80038	10	
37	0	.60181	.39818	1.6616	.75355	1.3270	1.2521	.20136	.79863		**53**
	10	.60413	.39586	1.6552	.75812	1.3190	1.2549	.20312	.79688	50	
	20	.60645	.39355	1.6489	.76271	1.3111	1.2577	.20488	.79512	40	
	30	.60876	.39124	1.6427	.76733	1.3032	1.2605	.20665	.79335	30	
	40	.61107	.38893	1.6365	.77196	1.2954	1.2633	.20842	.79158	20	
	50	.61337	.38663	1.6303	.77661	1.2876	1.2661	.21020	.78980	10	
38	0	.61566	.38434	1.6243	.78128	1.2799	1.2690	.21199	.78801		**52**
	10	.61795	.38205	1.6182	.78598	1.2723	1.2719	.21378	.78622	50	
	20	.62023	.37976	1.6123	.79070	1.2647	1.2748	.21558	.78441	40	
	30	.62251	.37748	1.6064	.79543	1.2572	1.2778	.21739	.78261	30	
	40	.62479	.37521	1.6005	.80020	1.2497	1.2807	.21921	.78079	20	
	50	.62706	.37294	1.5947	.80498	1.2423	1.2837	.22103	.77897	10	
39	0	.62932	.37068	1.5890	.80978	1.2349	1.2867	.22285	.77715		**51**
	10	.63158	.36842	1.5833	.81461	1.2276	1.2898	.22469	.77531	50	
	20	.63383	.36617	1.5777	.81946	1.2203	1.2929	.22653	.77347	40	
	30	.63608	.36392	1.5721	.82434	1.2131	1.2960	.22837	.77162	30	
	40	.63832	.36168	1.5666	.82923	1.2059	1.2991	.23023	.76977	20	
	50	.64056	.35944	1.5611	.83415	1.1988	1.3022	.23209	.76791	10	
40	0	.64279	.35721	1.5557	.83910	1.1917	1.3054	.23395	.76604		**50**
	10	.64501	.35499	1.5503	.84407	1.1847	1.3086	.23583	.76417	50	
	20	.64723	.35277	1.5450	.84906	1.1778	1.3118	.23771	.76229	40	
	30	.64945	.35055	1.5398	.85408	1.1708	1.3151	.23959	.76041	30	
	40	.65166	.34834	1.5345	.85912	1.1640	1.3184	.24149	.75851	20	
	50	.65386	.34614	1.5294	.86419	1.1571	1.3217	.24338	.75661	10	
41	0	.65606	.34394	1.5242	.86929	1.1504	1.3250	.24529	.75471		**49**
	10	.65825	.34175	1.5192	.87441	1.1436	1.3284	.24720	.75280	50	
	20	.66044	.33956	1.5141	.87955	1.1369	1.3318	.24912	.75088	40	
	30	.66262	.33738	1.5092	.88472	1.1303	1.3352	.25104	.74895	30	
	40	.66479	.33520	1.5042	.88992	1.1237	1.3386	.25297	.74702	20	
	50	.66697	.33303	1.4993	.89515	1.1171	1.3421	.25491	.74509	10	
42	0	.66913	.33087	1.4945	.90040	1.1106	1.3456	.25685	.74314		**48**
	10	.67129	.32871	1.4897	.90568	1.1041	1.3492	.25880	.74119	50	
	20	.67344	.32656	1.4849	.91099	1.0977	1.3527	.26076	.73924	40	
	30	.67559	.32441	1.4802	.91633	1.0913	1.3563	.26272	.73728	30	
	40	.67773	.32227	1.4755	.92170	1.0849	1.3600	.26469	.73531	20	
	50	.67987	.32013	1.4709	.92709	1.0786	1.3636	.26666	.73333	10	
43	0	.68200	.31800	1.4663	.93251	1.0724	1.3673	.26865	.73135		**47**
	10	.68412	.31588	1.4617	.93797	1.0661	1.3710	.27063	.72937	50	
	20	.68624	.31376	1.4572	.94345	1.0599	1.3748	.27263	.72737	40	
	30	.68835	.31164	1.4527	.94896	1.0538	1.3786	.27462	.72537	30	
	40	.69046	.30954	1.4483	.95451	1.0476	1.3824	.27663	.72337	20	
	50	.69256	.30744	1.4439	.96008	1.0416	1.3863	.27864	.72136	10	
44	0	.69466	.30534	1.4395	.96569	1.0355	1.3902	.28066	.71934		**46**
	10	.69675	.30325	1.4352	.97133	1.0295	1.3941	.28268	.71732	50	
	20	.69883	.30117	1.4310	.97699	1.0235	1.3980	.28471	.71529	40	
	30	.70091	.29909	1.4267	.98270	1.0176	1.4020	.28675	.71325	30	
	40	.70298	.29702	1.4225	.98843	1.0117	1.4060	.28879	.71121	20	
	50	.70505	.29495	1.4183	.99420	1.0058	1.4101	.29084	.70916	10	
45	0	.70711	.29289	1.4142	1.0000	1.0000	1.4142	.29289	.70711		**45**
		Co-sine.	*Vers. Sin.*	*Se-cant.*	*Co-tang.*	*Tan-gent.*	*Cose-cant.*	*Vers. Cos.*	*Sine.*		

Trigonometrical Functions.



Let angle $A\,O\,F$ be denoted by C.

$O\,A =$ radius R.

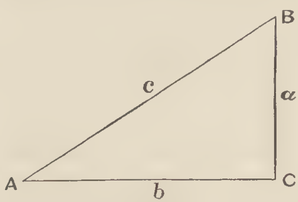
Sine	$C = F\,G$
Cosine	$C = O\,G$
Tangent	$C = A\,I$
Cotangent	$C = D\,L$
Secant	$C = O\,I$
Cosecant	$C = O\,L$
Versed sine	$C = G\,A$
Coversedsine	$C = D\,K$

Trigonometrical Equivalents.

Sine	$= \sqrt{1 - \text{cos.}^2}$	Cos.	$= \sqrt{1 - \text{sin.}^2}$
Sine	$=$ cos. $\div$ Cotang.	Cos.	$=$ sin. $\div$ Tang.
Tang.	$= 1 \div$ Cotang.	Cos.	$=$ sine $\times$ Cotang.
Cosec.	$= 1 \div$ Sine.	Tang.	$=$ Sine $\div$ Cosine.
Secant	$= 1 \div$ Cos.	Cotang.	$=$ Cosine $\div$ Sine.
Vers.	$=$ Rad. $-$ Cos.	$(\text{Rad.})^2$	$= \text{Sin.}^2 + \text{Cos.}^2$
Covers.	$=$ Rad. $-$ Sine.	$(\text{Secant})^2$	$= \text{Radius}^2 + \text{Tang.}^2$

Cotang. $= 1 \div$ Tang.

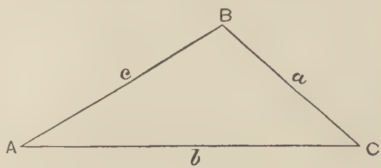
Right Angled Triangles.



Sin. $A = \frac{a}{c}$	Tang. $A = \frac{a}{b}$	Sec. $A = \frac{c}{b}$
Cos. $A = \frac{b}{c}$	Cot. $A = \frac{b}{a}$	Cosec. $A = \frac{c}{a}$

Given.	*Required.*	*Formulæ.*
a, c	A, B, b	$\text{Sin. } A = \frac{a}{c}$; $\cos. B = \frac{a}{c}$; $b = \sqrt{(c+a)(c-a)}$
a, b	A, B, c	$\text{Tang. } A = \frac{a}{b}$; $\cot. B = \frac{a}{b}$; $c = \sqrt{a^2 + b^2}$
A, a	B, b, c	$B = 90° - A$; $b = a \times \cot. A$; $c = \frac{a}{\sin. A}$
A, b	B, a, c	$B = 90° - A$; $a = b \times \text{tang. } A$; $c = \frac{b}{\cos. A}$
A, c	B, a, b	$B = 90° - A$; $a = c \times \sin. A$; $b = c \times \cos. A$

Oblique Angled Triangles.



A, B, a	b	$b = a \frac{\sin. B}{\sin. A}$
A, a, b	B	$\text{Sin. } B = \frac{b \sin. A}{a}$
a, b, C	$A - B$	$\text{Tang. } \frac{1}{2}(A - B) = \frac{(a - b) \text{ tang. } \frac{1}{2}(A + B)}{a + b}$
a, b, c	A	Let $S = \frac{1}{2}(a+b+c)$; $\sin. \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{b \times c}}$; $\cos. \frac{1}{2} A = \sqrt{\frac{s(s-a)}{bc}}$; $\text{tang. } \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$; $\sin. A = 2\sqrt{\frac{s(s-a)(s-b)(s-c)}{bc}}$
A, B, C, a	Area	$\text{Area} = \frac{a^2 \sin. B \sin. C}{2 \sin. A}$
A, b, c	Area	$\text{Area} = \frac{1}{2} b \times c \times \sin. A.$
a, b, c	Area	$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$ where $s = \frac{1}{2}(a + b + c)$

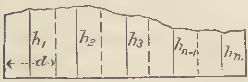
MENSURATION.

Triangle, Area = base × ½ perpendicular height.

Parallelogram, Area = base × perpendicular height.

Trapezoid, Area = ½ sum of parallel sides × perpendicular height.

AREA OF AN IRREGULAR PLANE SURFACE.



Divide the surface into any number of parallel strips of equal widths, "d" take the middle ordinates h_1, h_2, etc.

I. Area $= d \times \Sigma h + \frac{d}{12}(a - h_1) + \frac{d}{12}(b - h_n)$ (Poncelet's rule).

II. Area $= d \times \Sigma h + \frac{d}{72}(8a + h_2 - 9h_1) + \frac{d}{72}(8b + h_{n-1} - 9h_n)$ (Francke's rule).

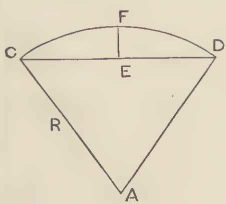
III. Area $= d \times \Sigma h$

Σ is symbol for sum of.

CIRCLE.

Circumference = 3.1416 × diameter.

Length of an arc = diameter × number of degrees in arc × 0.0087266.



Chord of arc $= CD = \sqrt{D^2 - (D - 2h)^2} = 2\sqrt{R^2 - (R - h)^2}$

Chord of ½ Arc $= \frac{1}{2}\sqrt{CD^2 + 4h^2} = \sqrt{D \times h}$

Diameter $= \dfrac{\frac{CD^2}{4} + h^2}{h}$

Versedsine $h = \frac{1}{2}(D - \sqrt{D^2 - CD^2})$ or nearly $\dfrac{CD^2}{8r}$

Area circle $= .7854\ (\text{diam.})^2$

Area Sector $ADFCA = \frac{R}{2} \times$ arc $DFC = \dfrac{3.1416 \times R^2 \times \text{angle } DAC \text{ in degrees}}{360}$

Area Segment $CDFC = \frac{1}{2}[\text{arc } DFC \times R - CD\,(R - h)]$

SPHERE.

Sphere, Surface $= 12.5664\ R^2 = 3.1416\ D^2$

Sphere, Volume $= 4.189\ R^3$

Spherical Sector, Surface $= 1.5708\ (4h + CD)$

Spherical Sector, Volume $= 2.0944\ R^2h = 2.0944\ R^2 \times \left(R \pm \sqrt{R^2 - \frac{CD^2}{4}}\right)$

Spherical Zone, Surface $= 6.2832 \times R \times h =$
$0.7854\ (\overline{CD}^2 + 4h^2)$
Spherical Zone, Volume $= 3.1416\ h^2\ (R - \frac{1}{3}\ h) =$

$$3.1416\ h^2 \left(\frac{\overline{CD}^2 + 4\ h^2}{8\ h} - \frac{1}{3}\ h\right)$$

ELLIPSE.

Circumference of an ellipse $= 3.1416 \sqrt{\frac{D^2 + d^2}{2}}$ approximately, where D is major axis and d the minor axis.

Area ellipse $= .7854\ D \times d$.

Ellipsoid surface $= 2.22\ d \sqrt{D^2 + d^2}$

" volume $= 0.5231\ D\ d^2$

PARABOLA.

Area of parabola $= \frac{2}{3}$ area of circumscribing rectangle.

Paraboloid volume $= 1.5707 \times$ altitude $\times$ square of radius of base.

CYLINDER.

Convex surface $= 3.1416 \times$ diam. of base $\times$ altitude.

Entire " $= 3.1416 \times$ diam. of base $\times$ altitude $+$ $1.5708 \times$ [diam.^{2}].

Volume $= 0.7854$ diam.$^2 \times$ altitude.

CONE.

Convex surface $=$ circumference of base $\times\ \frac{1}{2}$ slant height.

Volume $=$ area of base $\times\ \frac{1}{3}$ altitude.

Frustrum of Right Cone.

Convex surface $= 1.5708 \times$ slant height of frustrum $\times$ sum of diam. of bases.

Volume $= 0.2618 \times$ altitude $\times$ [square of diam. of lower base $+$ square of diam. of upper base $+$ product of 2 diameters.]

PRISM.

Convex surface $=$ perimeter of base $\times$ altitude.

Volume $=$ area of base $\times$ altitude.

PYRAMID.

Convex surface regular pyramid $=$ perimeter of base $\times\ \frac{1}{2}$ slant height.

Volume $=$ area base $\times\ \frac{1}{3}$ altitude.

Frustrum of a Regular Pyramid.

Convex surface $= \frac{1}{2}$ slant height $\times$ sum of perimeters of bases.

Volume $= \frac{1}{3}$ altitude $\times$ [sum of areas of 2 bases $+$ square root of product of the 2 bases.]

ELECTRICAL FORMULÆ.

STANDARDS OF MEASUREMENT.

The centimeter, gramme, and second are the units of space, mass and time.

Unit of velocity = space ÷ time = 1 cm. in 1 second.

Unit of acceleration = change of 1 unit of velocity in 1 second.

Acceleration, due to gravity at Paris, = 981 centimeters in one second.

Unit of force = 1 dyne = $\frac{1}{981}$ gm. = .000002247 pounds.

A dyne is that force which, acting on a mass of 1 gm. during 1 second, will give it a velocity of 1 cm. per second.

Unit of work = 1 erg = 1 dyne-centimeter = .00000007373 foot-pounds.

Unit of power = 1 watt = 10 million ergs per second.

1 watt = $\frac{1}{746}$ of 1 h. p. = .00134 h. p.

C. G. S. Unit of magnetism = the quantity which attracts or repels an equal quantity at a centimeter's distance with the force of 1 dyne.

C. G. S. Unit of electrical current = the current which, flowing through a length of 1 centimeter of wire, acts with a force of 1 dyne upon a unit of magnetism distant 1 centimeter from every point of the wire.

PRACTICAL UNITS.

Ampere—the unit of current strength, represented by C.

Volt—the unit of electro-motive force, represented by E.

Ohm—the unit of resistance, represented by R.

Coulomb—the unit of quantity.

Ampere-hour = 3600 coulombs = represented by Q^1.

Watt—the unit of power = volt-ampere = P.

Joule—the unit of work = volt-coulomb = W.

Farad—the unit of capacity, represented by K, the one-millionth of the Farad, or micro-farad, is the usual unit.

Henry—the unit of induction.

The following formulæ give the relation between these units: $t = 1$ second, $T = 1$ hour.

$$C = \frac{E}{R},\ Q = Ct,\ Q^1 = CT,\ K = \frac{Q}{E},\ W = QE,\ P = CE.$$

By combination the following formulæ are derived:

$$Q = \frac{E}{R}t,\ K = \frac{C}{E}t,\ W = CE\,t = \frac{E^2}{R}t = C^2Rt = Pt,$$

$$P = \frac{E^2}{R} = C^2R = \frac{W}{t} = \frac{QE}{t}$$

The relation between the practical units and the C. G. S. Units is:

1 Ampere	$= 10^{-1}$	C. G. S.	Units.
1 Volt	$= 10^{8}$	"	"
1 Ohm	$= 10^{9}$	"	"
1 Coulomb	$= 10^{-1}$	"	"
1 Farad	$= 10^{-9}$	"	"
1 Volt-coulomb	$= 10^{7}$	"	"
1 Watt (volt-ampere)	$= 10^{7}$	"	"

Equivalents of Work.

Work = Power × Time.

1 Volt-coulomb	= 1 Watt (volt-ampere) per second.
(Joule)	= .737324 foot-pounds.
	= .101937 Kilogrammeters.
	= .00134059 H. P. per second.
	= .000022343 H. P. per minute.
1 Foot-pound	= 1.35626 Volt-coulombs.
1 Kilogrammeter	= 9.81 " "
1 H. P. per second	= 745.941 " "
1 H. P. per min.	= 44756.47 " "

Equivalents of Power.

$$\text{Power} = \frac{\text{Work}}{\text{Time}}.$$

1 Watt	= 1 Volt-coulomb per second.
	= .00134059 Horse-power.
(Volt-ampere)	= .737324 foot-pounds per second.
	= 44.23944 " " minute.
	= 2654.3664 " " hour.
1 Horse-power	= 745.941 Watts (Volt-ampères).
1 Foot-lb. per sec.	= 1.35626 " " "
1 Foot-lb. per min.	= .0226043 " " "

DIMENSIONS, WEIGHT AND RESISTANCE OF BARE COPPER WIRE.

B & S Gauge	Diam. in Mils 1 Mil =.001″	Area in Circ. Mils d^2.	Wt. of 1000 Feet in Lbs.	Length in Feet of 1 Lb.	Resistance @ 68° F. Ohms per 1000 Feet.	Ohms per Mile.	Feet per Ohm.	Ohms per 100 Lbs.	Current in Amperes. Exposed.	Concea'd
4—0	460.000	211600.00	640.5	1.561	.049	.258	20440	.00764	345	175
3—0	409.642	167806.43	508.0	1.969	.062	.326	16210	.01215	290	145
2—0	364.796	133077.66	402.8	2.482	.078	.411	12850	.01931	245	120
0	324.861	105535.50	319.5	3.130	.098	.518	10900	.03071	210	100
1	289.296	83693.67	253.3	3.947	.124	.653	8083	.04883	175	85
2	257.626	66371.31	200.9	4.977	.156	.824	6410	.07765	145	73
3	229.422	52634.37	159.3	6.276	.197	1.039	5084	.1235	125	60
4	204.307	41741.32	126.4	7.914	.248	1.309	4031	.1936	110	50
5	181.941	33102.37	100.2	9.980	.313	1.652	3197	.3122	90	45
6	162.022	26251.37	79.56	12.58	.394	2.083	2535	.4963	80	35
7	144.285	20818.35	63.02	15.87	.497	2.626	2011	.7892	65	30
8	128.490	16510.64	49.98	20.01	.627	3.311	1595	1.255	55	25
9	114.434	13093.75	39.63	25.23	.791	4.175	1265	1.995	48	20
10	101.897	10383.02	31.43	31.82	.997	5.127	1003	3.173	40	17
11	90.743	8234.11	24.93	40.12	1.257	6.637	795.3	5.045	35	15
12	80.808	6529.95	19.77	50.59	1.586	8.374	630.7	8.022	30	13
13	71.962	5178.58	15.68	63.79	1.999	10.56	500.1	12.76	25	10
14	64.084	4106.72	14.43	80.44	2.521	13.31	396.6	20.28	22	8
15	57.069	3256.88	9.86	101.4	3.179	16.79	314.5	32.25	19	7
16	50.821	2582.74	7.82	127.9	4.009	21.17	249.4	51.28	16	6
17	45.257	2048.39	6.20	161.3	5.055	26.69	197.8	81.53	14	5
18	40.303	1624.30	4.92	203.4	6.374	33.66	156.9	129.6	12	5
19	35.890	1288.13	3.90	256.5	8.038	42.41	124.4	206.1	11	4
20	31.961	1022.53	3.09	323.4	10.14	53.54	98.66	327.8	9	3

CAPACITY OF CABLES.

Area in Circular Mils.	Amperes. Open.	Concealed.	Area in Circular Mils.	Amperes. Open.	Concealed.
200000	300	200	1200000	1145	715
300000	405	270	1300000	1215	755
400000	500	335	1400000	1285	795
500000	595	395	1500000	1355	835
600000	680	445	1600000	1425	875
700000	765	495	1700000	1490	910
800000	845	540	1800000	1555	945
900000	925	585	1900000	1620	980
1000000	1000	630	2000000	1680	1015
1100000	1075	675			

AVOIRDUPOIS OR COMMERCIAL WEIGHTS.

Gross Ton.	*Cwts.*	*Pounds.*	*Ounces.*
1	20	2240	35840
	1	112	1792
		1	16

LONG MEASURE.

Miles.	*Rods.*	*Yards.*	*Feet.*	*Inches.*
1	320	1760	5280	63360
	1	5.5	16.5	198
		1	3	36
			1	12

SQUARE MEASURE.

Sq. Miles.	*Acres.*	*Sq. Rods.*	*Sq. Yards.*	*Sq. Feet.*	*Sq. Inches.*
1	640	102400	3097600	27878400	
	1	160	4840	43560	6272640
		1	30.25	272.25	39204
			1	9	1296
				1	144

CUBIC MEASURE.

Cubic Yard.	*Cubic Feet.*	*Cubic Inches.*	*Struck Bushel.*	*Wine Gallon.*
1	27	46656	21.7005	201.974
	1	1728	0.8036	7.4805
0.0461	1.2445	2150.42	1	9.3092
	0.1337	231.	0.1074	1.0

1 heaped bushel = $1\frac{1}{4}$ struck bushel.
1 cord of wood = a pile $4 \times 4 \times 8$ feet = 128 cubic feet.
1 perch of masonry = $16\frac{1}{2} \times 1\frac{1}{2} \times 1$ foot = $24\frac{3}{4}$ "

LIQUID MEASURE.

Barrel.	*Gallons.*	*Quarts.*	*Pints.*	*Gills.*
1	31.5	126	252	1008
	1	4	8	32
		1	2	8
			1	4

METRIC SYSTEM.

LINEAR MEASURE.			*MEASURE OF SURFACE.*		
Denomination.	*Abbr.*	*Value.*	*Denomination.*	*Abbr.*	*Value.*
Myriameter	. . .	10000 meters	Sq. Kilometer	km^2	1000000 $m.^2$
Kilometer	km.	1000 "	Hektar	ha.	10000 $m.^2$
Hectometer	. . .	100 "	Are	a	100 $m.^2$
Dekameter	. . .	10 "	{ Centare	. .	1 $m.^2$
Meter	m.	1 "	{ Square Meter	$m.^2$	1 $m.^2$
Decimeter	dm.	.1 "	Sq. Decimeter	$dm.^2$	.01 $m.^2$
Centimeter	cm.	.01 "	Sq. Centime'r	$m.^2$	.0001 $m.^2$
Millimeter	mm.	.001 "	Sq. Millimeter	$mm.^2$	.000001 $m.^2$

MEASURES OF VOLUME.			*MEASURES OF MASS.*		
{ Kiloliter	. .	1000 liters	{ Millier	. . .	1000 kilos
{ Stere	s.	" "	{ Tonneau	. . .	" "
{ Cubic Meter	$m.^3$	" "	{ Metric Ton	t.	" "
Hectoliter	hl.	100 "	Quintal	. . .	100 "
Dekaliter	dal	10 "	Myriagram	. . .	10 "
{ Cubic Decimeter	$dm.^3$	1 "	{ Kilogram	kg	1000 grams
{ Liter	l.	1 "	{ Kilo	. . .	" "
Deciliter	dl.	.1 "	Hectogram	. . .	100 "
Centiliter	cl.	.01 "	Dekagram	. . .	10 "
{ Cubic Centimeter	cm^3.	.001	Gram	g.	1 "
{ Milliliter	ml.	.001 liter	Decigram	dg.	.1 "
Cubic Millimeter	$mm.^3$	.000001 "	Centigram	cg.	.01 "
Microliter	λ	.001 m. l.	Milligram	mg.	.001 "
			Microgram	y.	.001 m. g.

METRIC CONVERSION TABLE.

Millimeters	× .03937 =	inches.	
"	÷ 25.4 =	"	
Centimeters	× .3937 =	"	
"	÷ 2.54 =	"	
Meters	× 39.37 =	"	(Act of Congress.)
"	× 3.281 =	feet.	
"	× 1.094 =	yards.	
Kilometers	× .621 =	miles.	
"	÷ 1.6093 =	"	
"	× 3280.7 =	feet.	
Square Millimeters	× .00155 =	square inches.	
" "	÷ 645.1 =	" "	
Square Centimeters	× .155 =	" "	
" "	÷ 6.451 =	" "	
Square Meters	× 10.764 =	" feet.	

METRIC CONVERSION TABLE—*Continued.*

Square Kilometers	×	247.1	=	acres.
Hektares	×	2.471	=	acres.
Cubic Centimeters	÷	16.383	=	cubic inches.
" "	÷	3.69	=	fluid drachms.
" "	÷	29.57	=	fluid ounce.
" Meters	×	35.315	=	cubic feet.
" "	×	1.308	=	cubic yards.
" "	×	264.2	=	gallons (231 cu. in.).
Liters	×	61.022	=	cubic inches (Act of Congress).
"	×	33.84	=	fluid ounce (U. S. Phar.).
"	×	.2642	=	gallons (231 cu. in.).
"	÷	3.78	=	" " "
"	÷	28.316	=	cubic feet.
Hectoliters	×	3.531	=	" "
"	×	2.84	=	bushels (2150.42 cu. in.).
"	×	.131	=	cubic yards.
"	×	26.42	=	gallons (231 cu. in.).
Grams	×	15.432	=	grains (Act of Congress).
"	×	981	=	dynes.
" (water)	÷	29.57	=	fluid ounces.
"	÷	28.35	=	ounces avoirdupois.
" per cu. cent.	÷	27.7	=	pounds per cubic inches.
Joule	×	.7373	=	foot-pounds.
Kilograms	×	2.2046	=	pounds.
"	×	35.3	=	ounce, avoirdupois.
"	÷	907.2	=	tons (2000 lbs.).
" per sq. cent.	×	14.223	=	pounds per sq. in.
Kilogrammeters	×	7.233	=	foot-pounds.
Kilograms per lineal meter	×	.672	=	pounds per lineal ft.
" " square "	×	.205	=	pounds per square ft.
" " cubic "	×	.062	=	pounds per cubic ft.
" " cheval-vapeur	×	2.235	=	lbs. per H. P.
Kilo-watts	×	1.34	=	horse-power.
Watts	÷	746	=	" "
"	×	.7373	=	foot-pounds per second.
Calorie	×	3.968	=	B. T. U.
Cheval-vapeur	×	.9863	=	horse-power.
(Deg. Centigrade	×	1.8) + 32	=	degrees Fahrenheit.
Francs	×	.193	=	dollars.
Gravity, Paris			=	980.94 centimeters per second.
1 Admiralty knot			=	1.853 kilometers.

1 Atmosphere is the pressure of a column of 76 centimeters of mercury at the temperature of melting ice at Paris, where it is equal to 1.0333 kilos on a square centimeter.

PRODUCT OF FRACTIONS EXPRESSED IN DECIMALS.

0	1	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
$\frac{1}{16}$	.0625	.0039															
$\frac{1}{8}$	.1250	.0078	.0156														
$\frac{3}{16}$	.1875	.0117	.0234	.0351													
$\frac{1}{4}$	.2500	.0156	.0313	.0469	.0625												
$\frac{5}{16}$	.3125	.0195	.0391	.0587	.0781	.0977											
$\frac{3}{8}$	.3750	.0234	.0469	.0705	.0937	.1172	.1406										
$\frac{7}{16}$	.4375	.0273	.0547	.0823	.1093	.1367	.1641	.1914									
$\frac{1}{2}$	.5000	.0313	.0625	.0938	.1250	.1562	.1875	.2188	.2500								
$\frac{9}{16}$	.5625	.0352	.0703	.1056	.1406	.1757	.2110	.2462	.2813	.3164							
$\frac{5}{8}$	.6250	.0391	.0781	.1172	.1562	.1952	.2343	.2734	.3125	.3516	.3906						
$\frac{11}{16}$	.6875	.0430	.0859	.1289	.1718	.2148	.2578	.3007	.3438	.3867	.4297	.4727					
$\frac{3}{4}$	.7500	.0469	.0938	.1406	.1875	.2344	.2813	.3281	.3750	.4219	.4686	.5156	.5625				
$\frac{13}{16}$	.8125	.0508	.1016	.1523	.2031	.2539	.3047	.3555	.4063	.4570	.5078	.5586	.6094	.6601			
$\frac{7}{8}$	.8750	.0547	.1094	.1640	.2187	.2734	.3281	.3828	.4375	.4922	.5469	.6016	.6563	.7109	.7656		
$\frac{15}{16}$	.9375	.0586	.1172	.1757	.2343	.2929	.3515	.4102	.4688	.5274	.5859	.6445	.7031	.7617	.8203	.8789	
1	1.000	.0625	.1250	.1875	.2500	.3125	.3750	.4375	.5000	.5625	.6250	.6875	.7500	.8125	.8750	.9375	1.000

INDEX.

PLATES

OF

PENCOYD

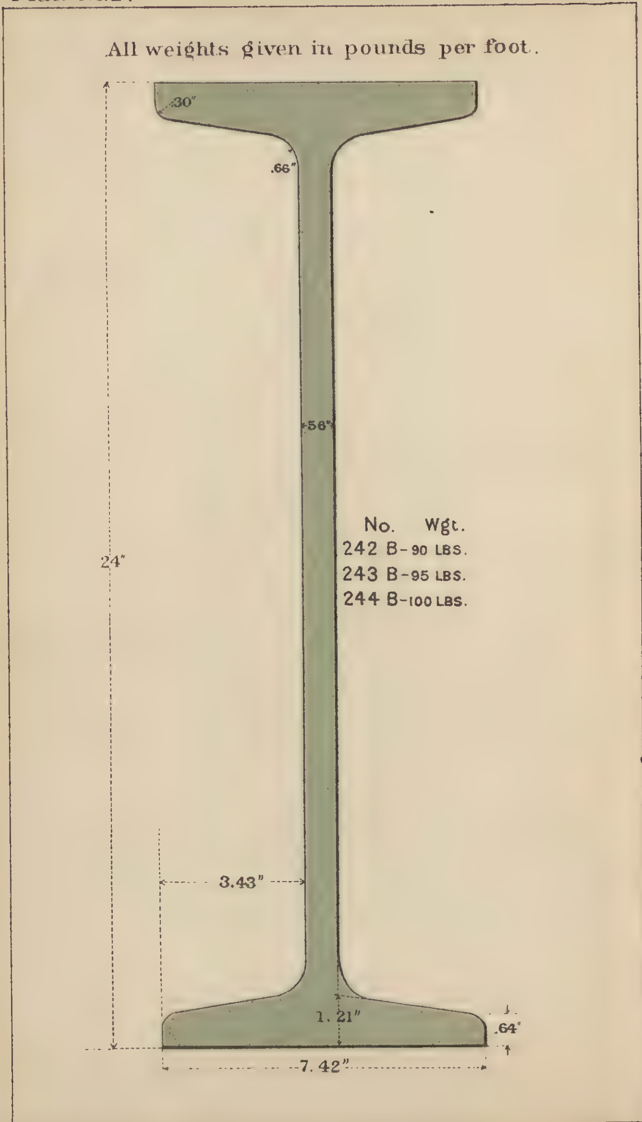
STEEL

SECTIONS.

The dimensions belong to the least sections. Several sections of beams and channels are rolled, which are not shown in lithographs. Some particulars of these will be found in the tables, or definite information will be furnished on application.

JULIUS BIEN & CO. N Y

Plate No. 1.


All weights given in pounds per foot.
.30"
.66"
.56"
24"
No. Wgt.
242 B-90 LBS.
243 B-95 LBS.
244 B-100 LBS.
3.43"
1.21"
.64"
7.42"

All weights given in pounds per foot.

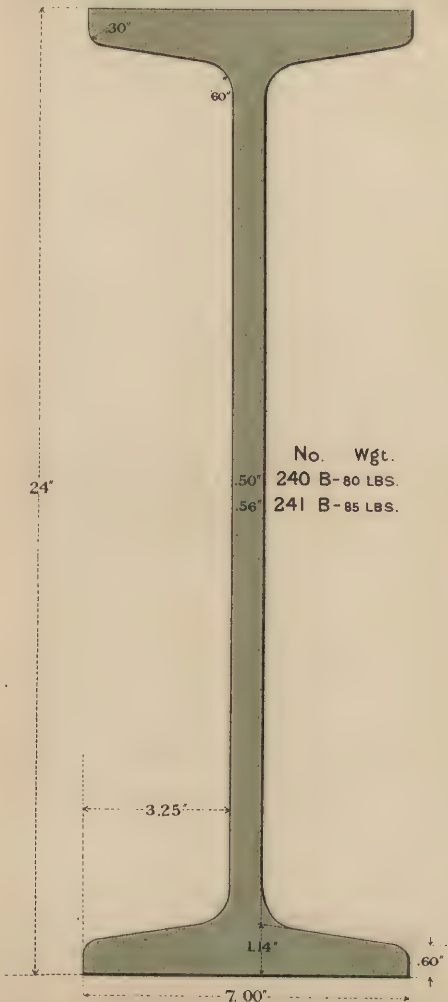
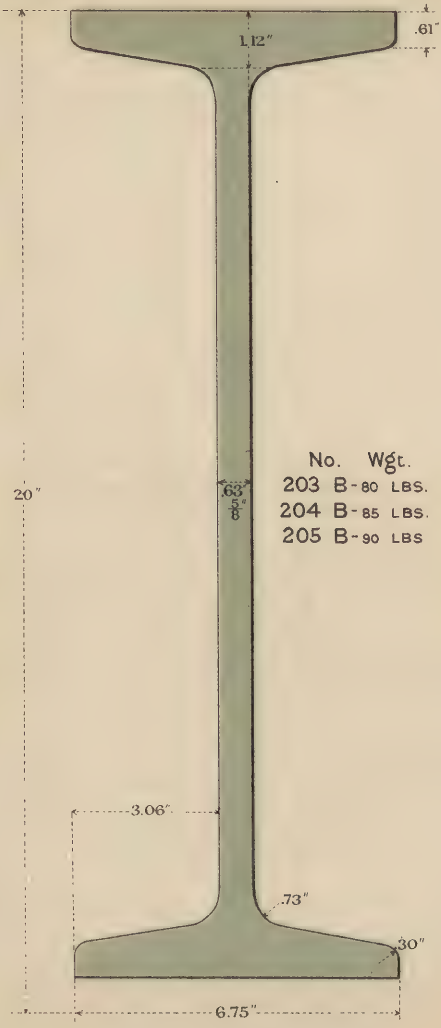


Plate No. 3.

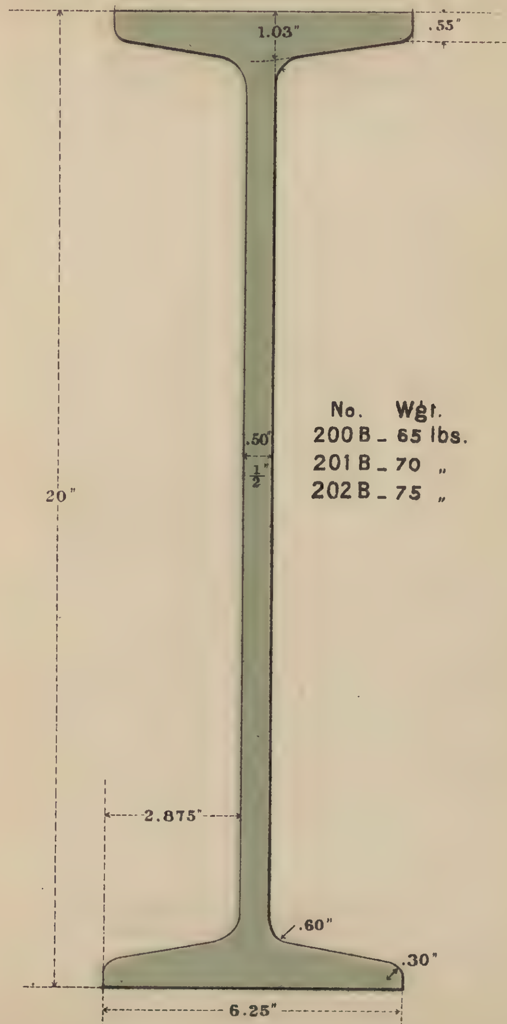
All weights given in pounds per foot.



No.	Wgt.
203 B	80 LBS.
204 B	85 LBS.
205 B	90 LBS

Plate No. 4.

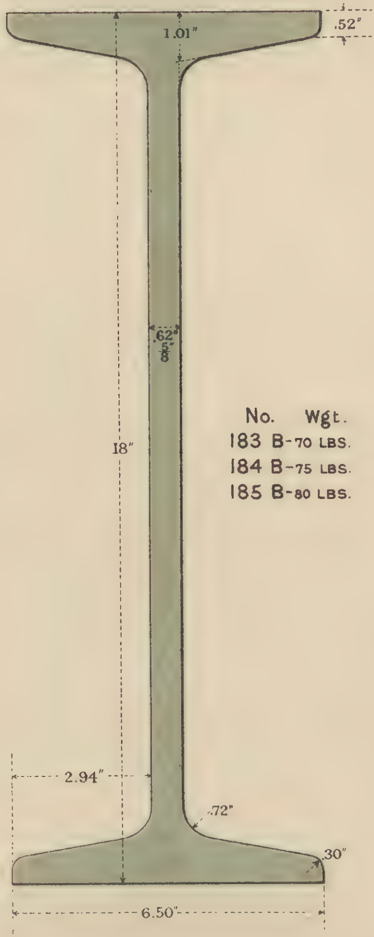
All weights given in pounds per foot.



No.	Wgt.
200 B	65 lbs.
201 B	70 "
202 B	75 "

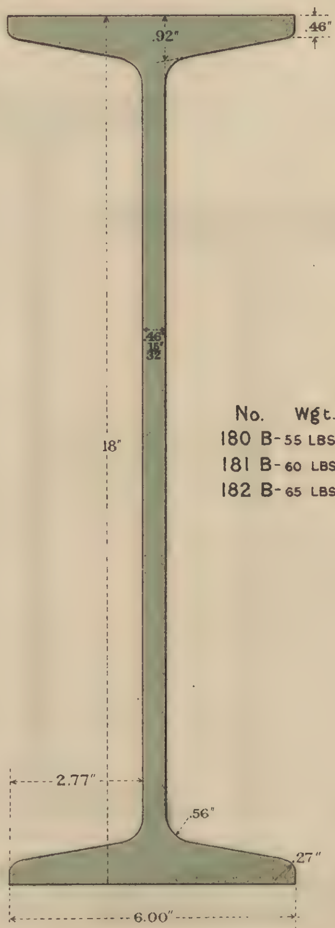
Plate No. 5.

All weights given in pounds per foot.



No.	Wgt.
183 B	70 LBS.
184 B	75 LBS.
185 B	80 LBS.

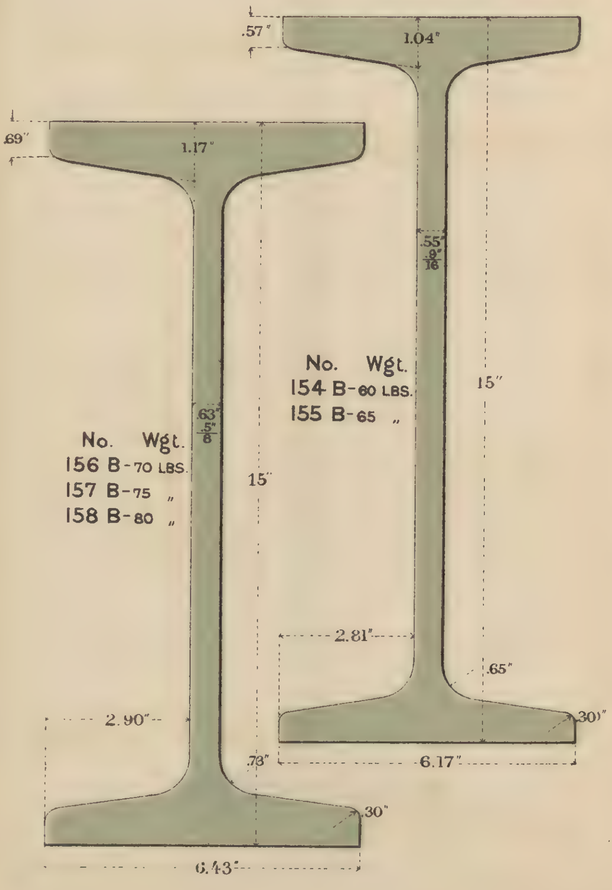
All weights given in pounds per foot



No.	Wgt.
180 B	55 LBS.
181 B	60 LBS.
182 B	65 LBS.

Plate No. 7.

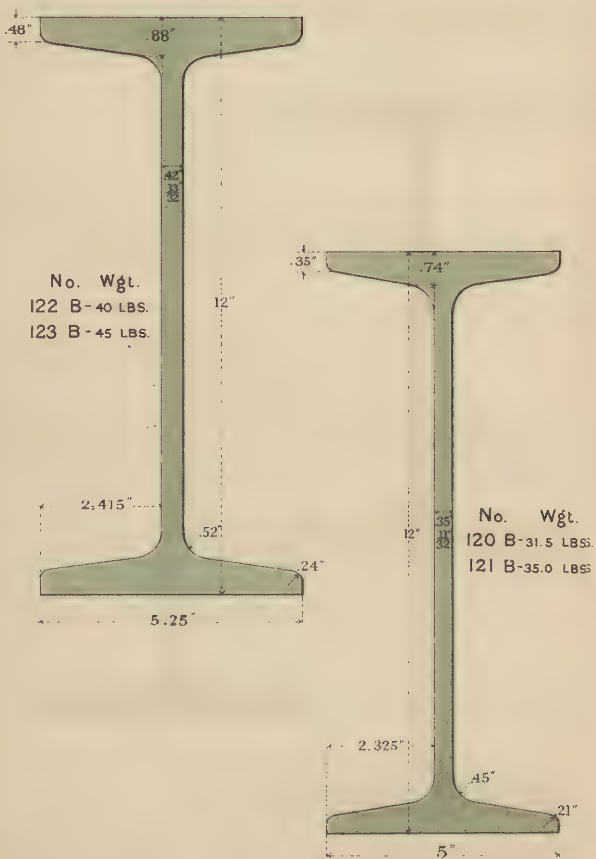
All weights given in pounds per foot



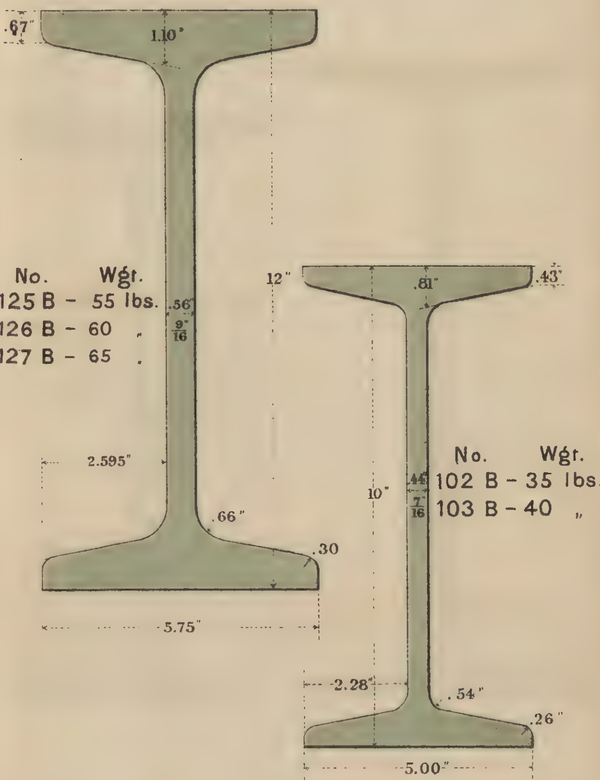
All weights given in pounds per foot

Plate No. 9.

All weights given in pounds per foot.



All weights given in pounds per foot.



No.	Wgt.
125 B	55 lbs.
126 B	60 "
127 B	65 "

No.	Wgt.
102 B	35 lbs.
103 B	40 "

Plate No. 11.

All weights given in pounds per foot.

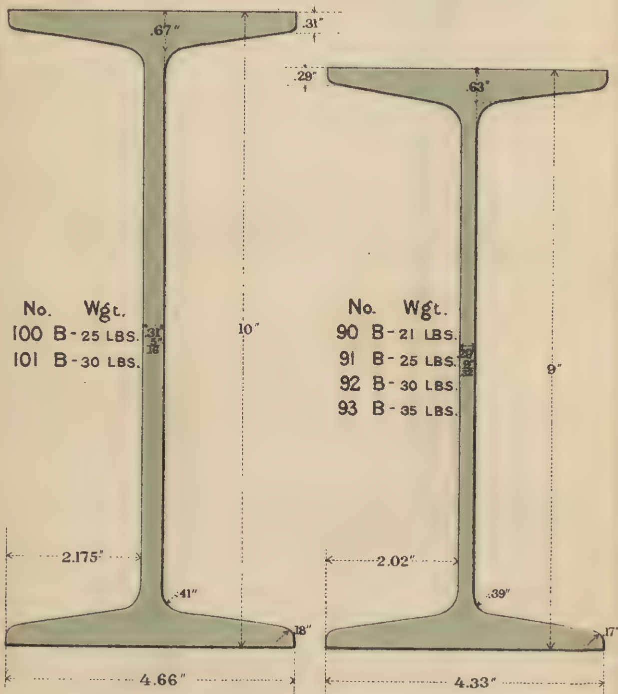


Plate No.12.

All weights given in pounds per foot

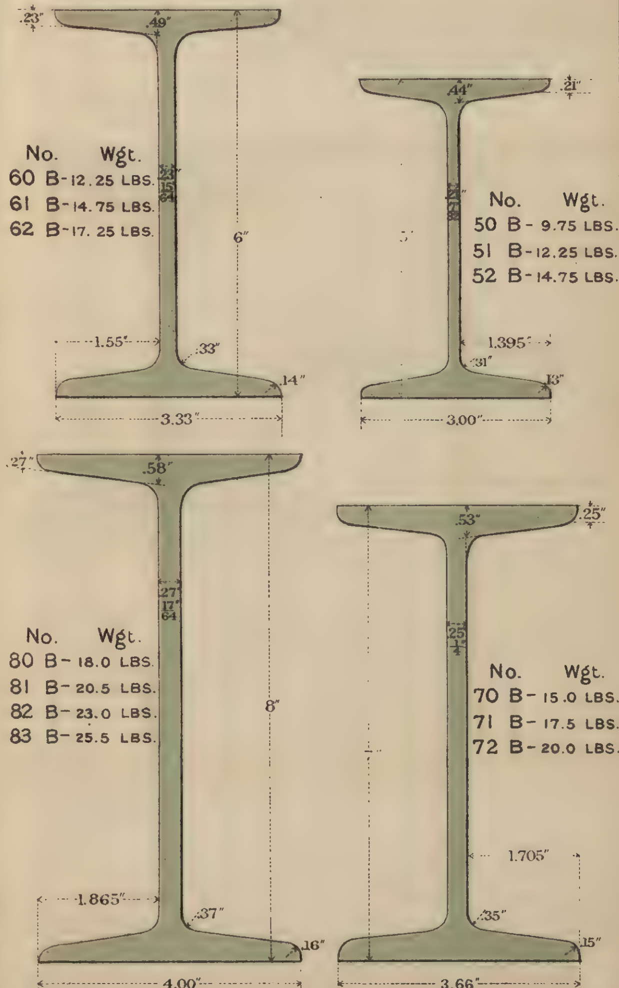
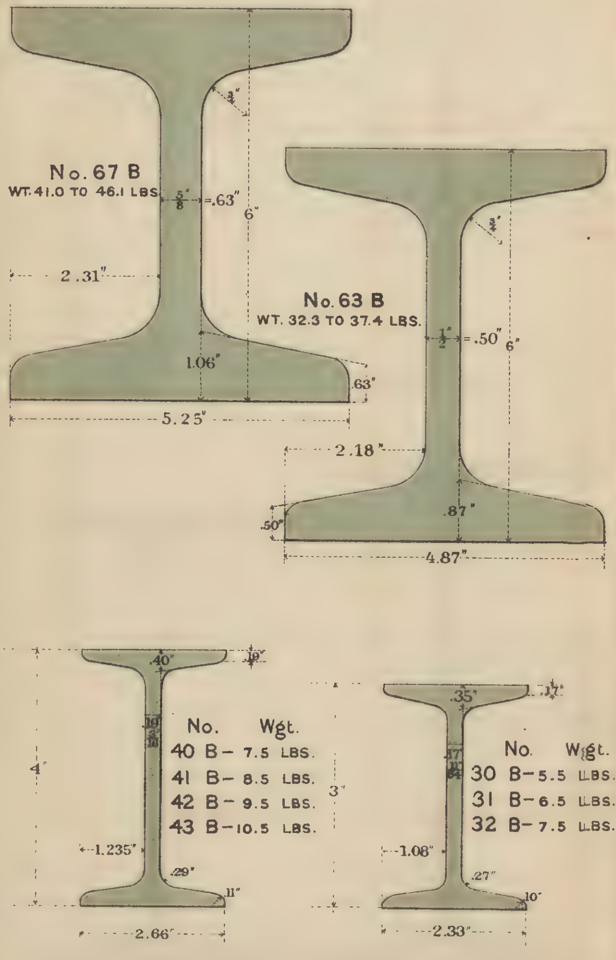


Plate No. 13

All weights given in pounds per foot.



All weights given in pounds per foot.

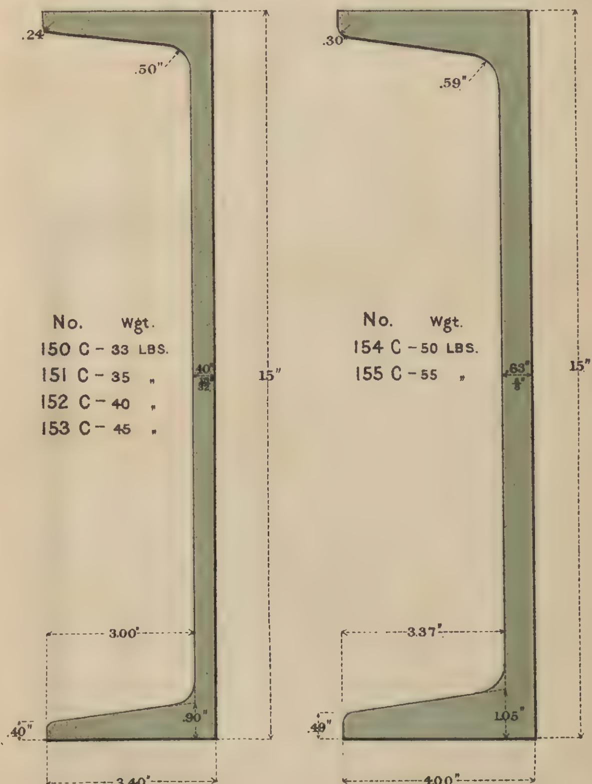
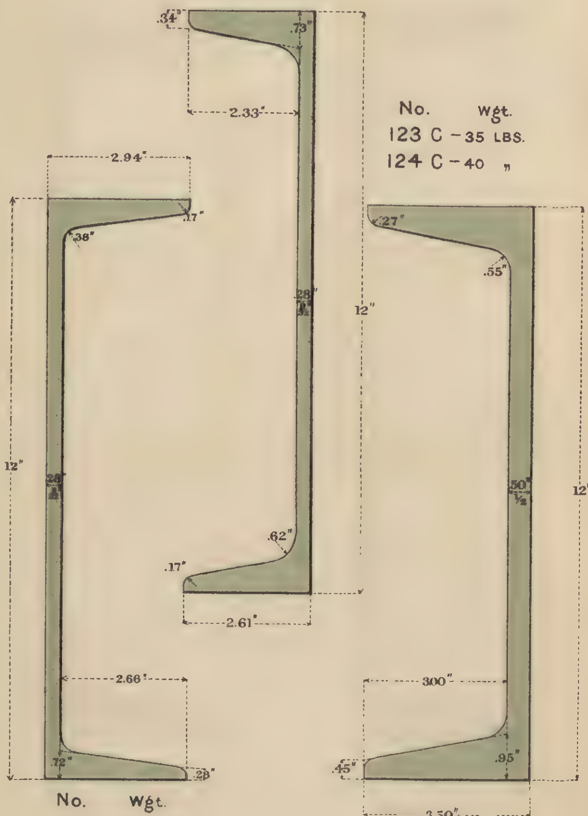


Plate No. 15.

All weights given in pounds per foot.

No. 128 C

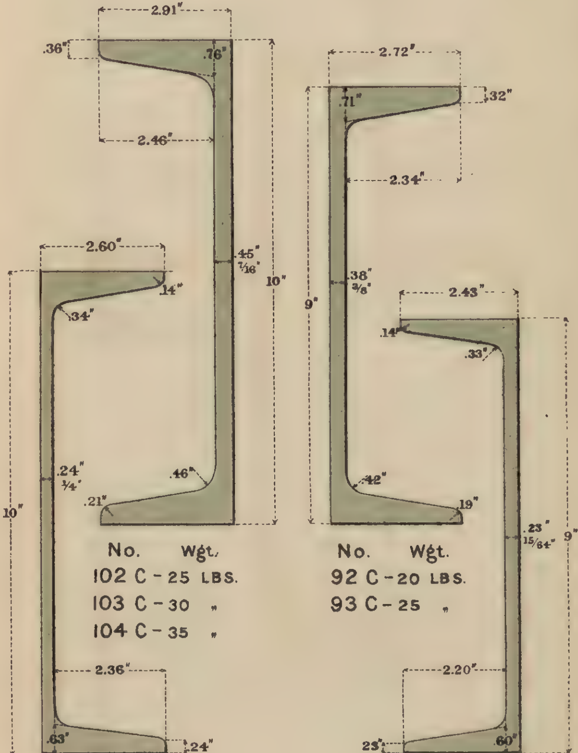
WT. 20.5 TO 32.0 LBS.



No. Wgt.
123 C – 35 LBS.
124 C – 40 „

No. Wgt.
120 C – 20.5 LBS.
121 C – 25.0 „
122 C – 30.0 „

All weights given in pounds per foot.



No.	Wgt.
102 C	25 LBS.
103 C	30 "
104 C	35 "

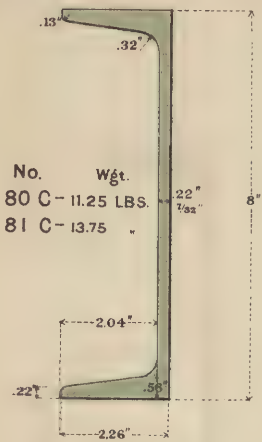
No.	Wgt.
92 C	20 LBS.
93 C	25 "

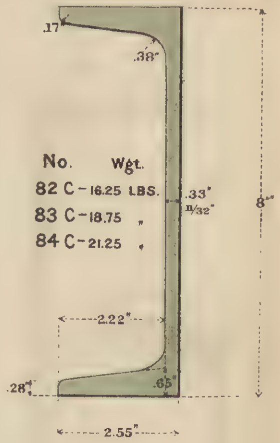
No.	Wgt.
100 C	15 LBS.
101 C	20 "

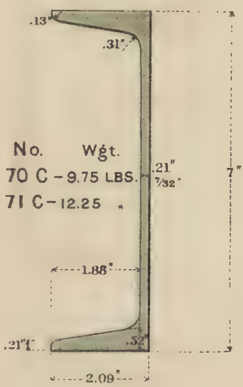
No.	Wgt.
90 C	13.25 LBS.
91 C	15.00 "

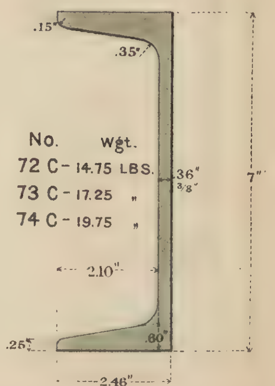
Plate No. 17.

All weights given in pounds per foot.









All weights given in pounds per foot.

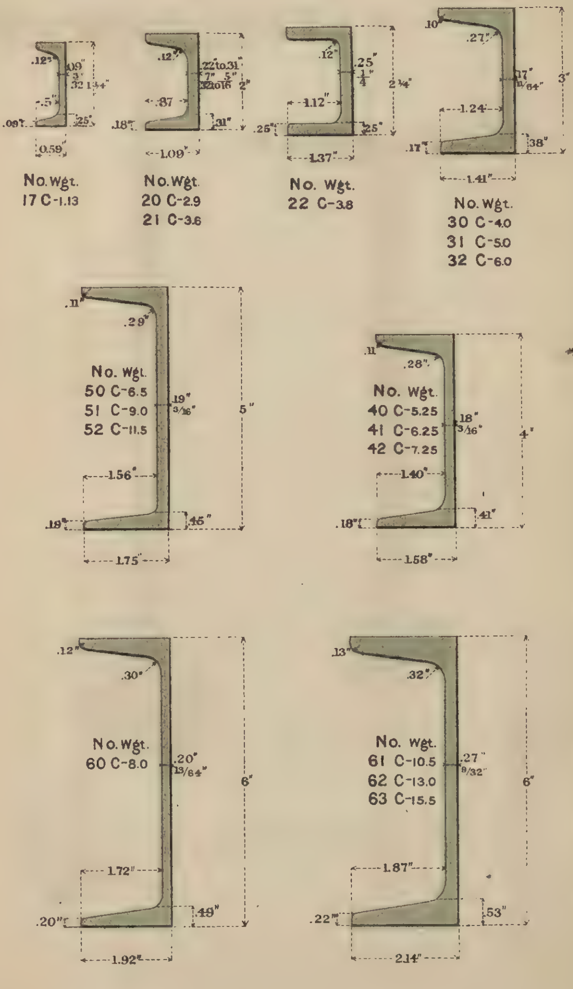
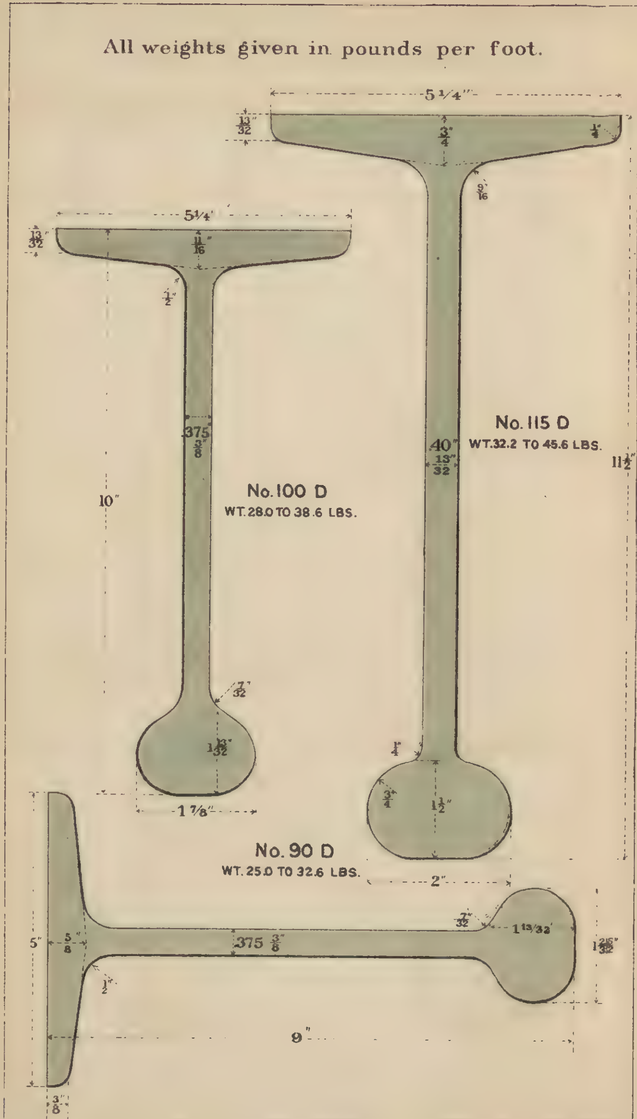


Plate No. 19.


All weights given in pounds per foot.
No. 115 D
WT. 32.2 TO 45.6 LBS.
No. 100 D
WT. 28.0 TO 38.6 LBS.
No. 90 D
WT. 25.0 TO 32.6 LBS.
5 1/4"
5 1/4"
10"
11 1/2"
9"
5"
2"
1 7/8"
1 13/32"
.375
.40"

All weights given in pounds per foot.

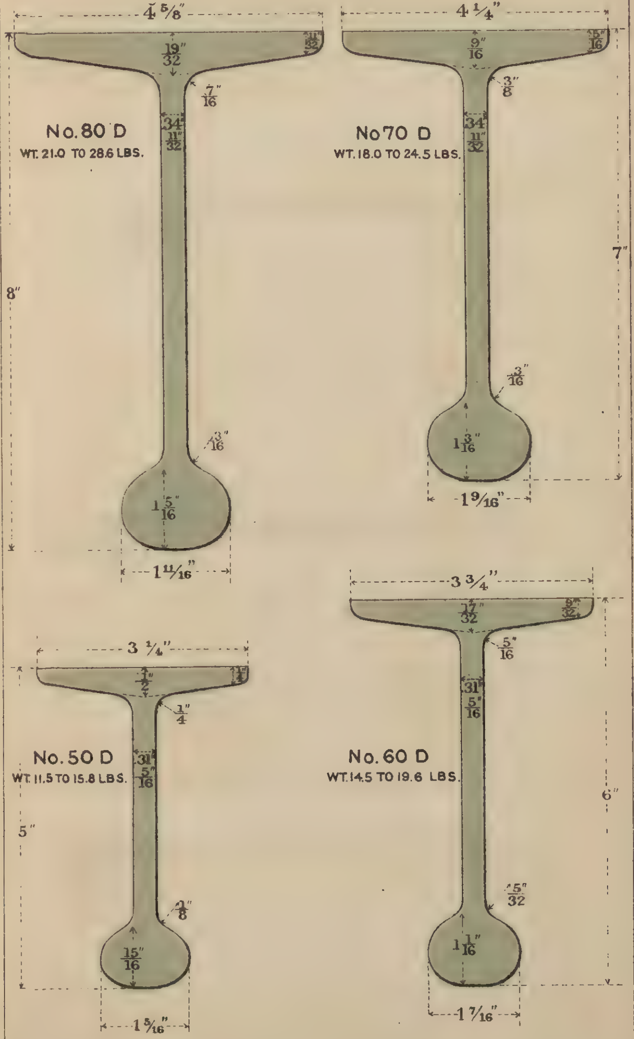
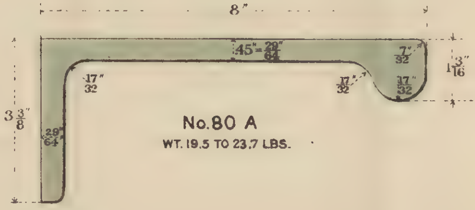
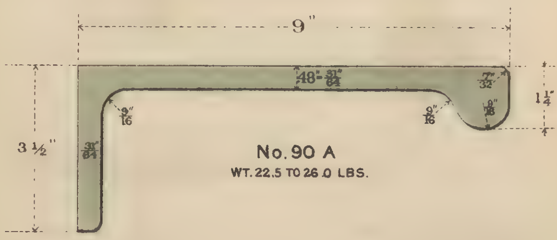


Plate No. 21.

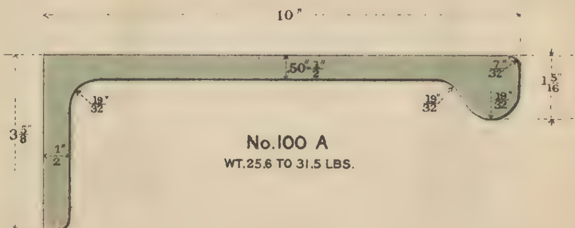
All weights given in pounds per foot.



No. 80 A
WT. 19.5 TO 23.7 LBS.

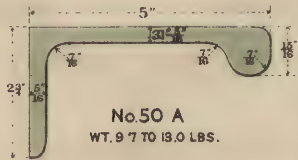


No. 90 A
WT. 22.5 TO 26.0 LBS.

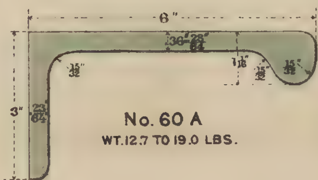


No. 100 A
WT. 25.6 TO 31.5 LBS.

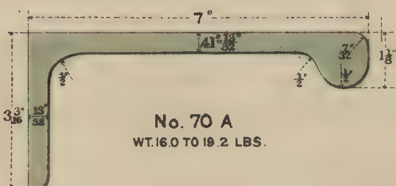
All weights given in pounds per foot



No. 50 A
WT. 9.7 TO 13.0 LBS.



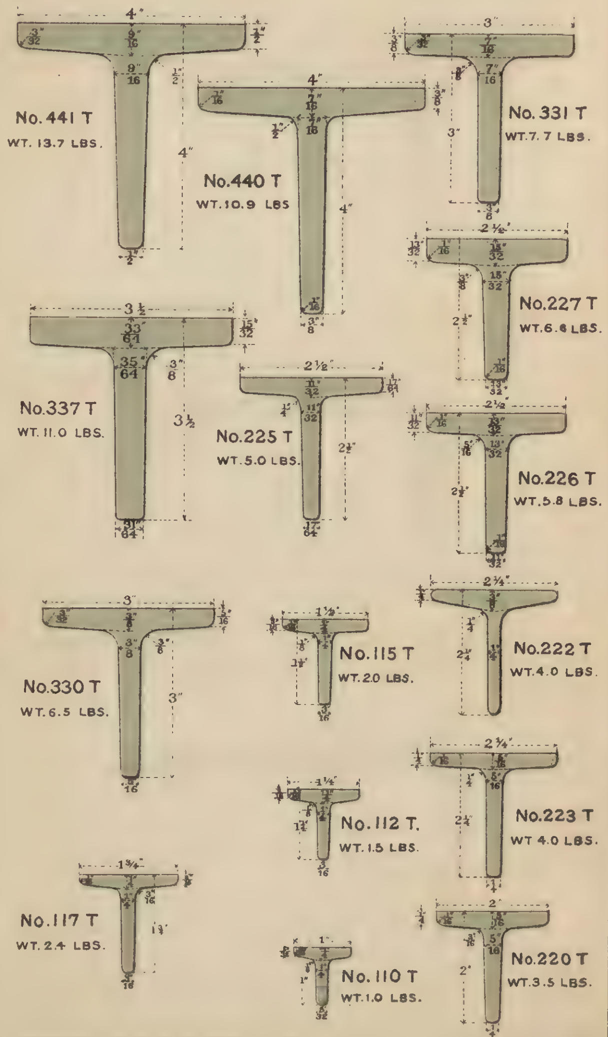
No. 60 A
WT. 12.7 TO 19.0 LBS.



No. 70 A
WT. 16.0 TO 19.2 LBS.

Plate No. 23.

All weights given in pounds per foot



All weights given in pounds per foot.

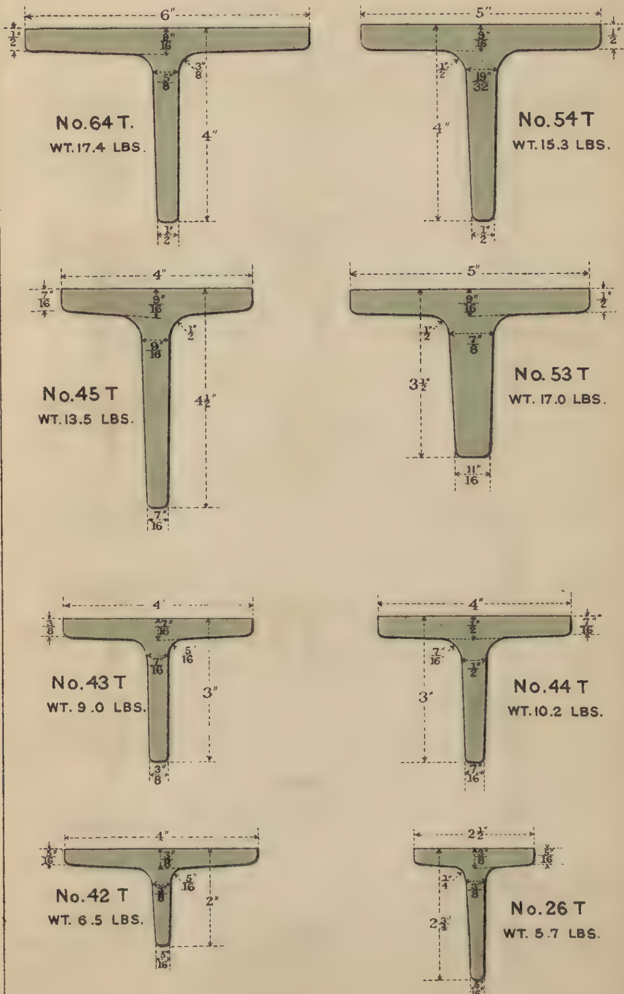
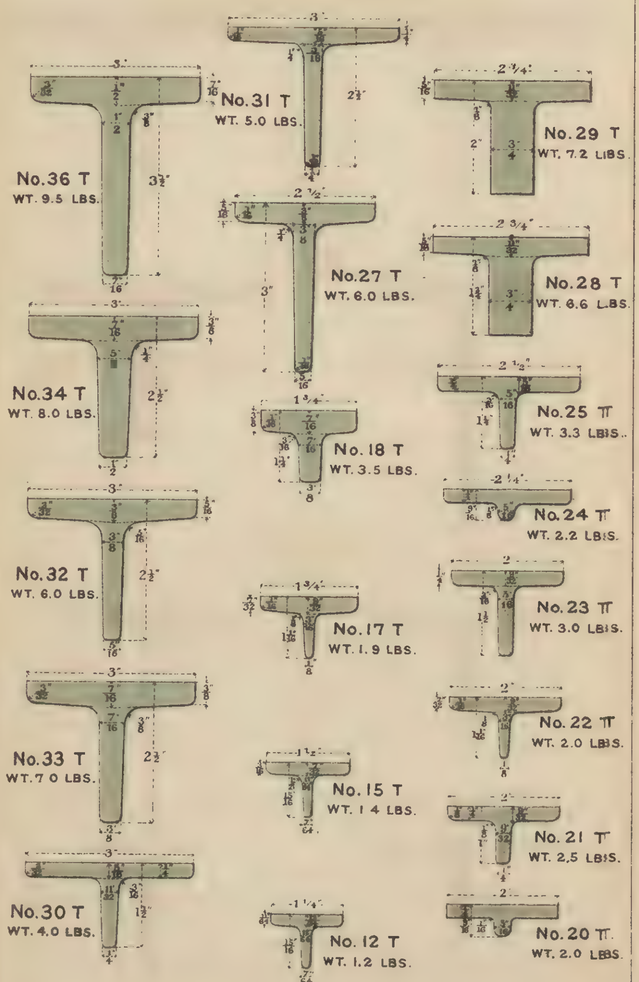


Plate No.25.

All weights given in pounds per foot. nt.



All weights given in pounds per foot.

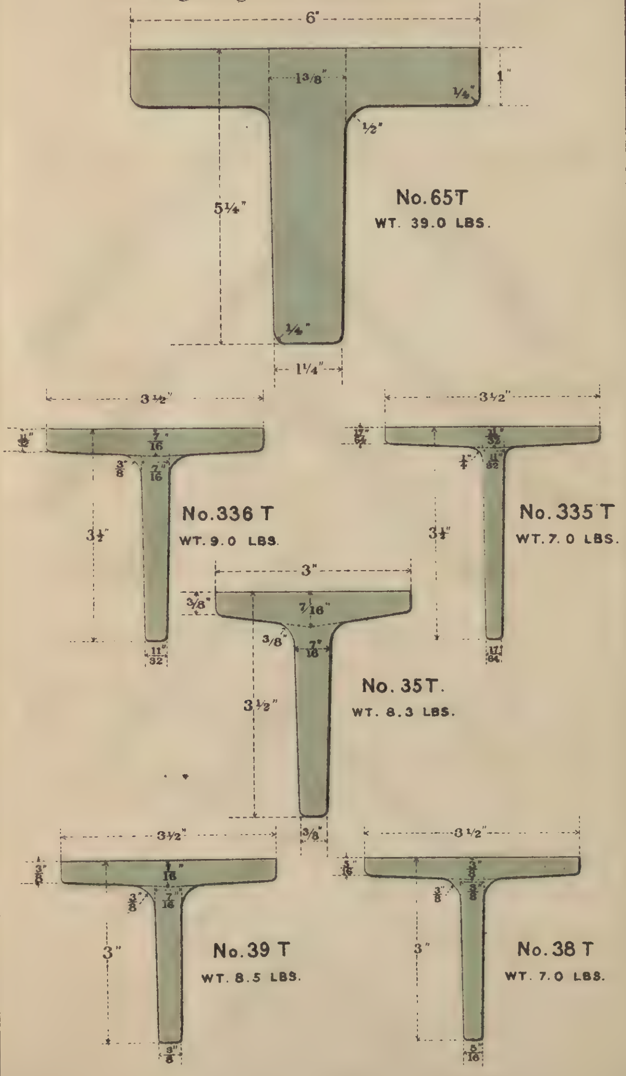
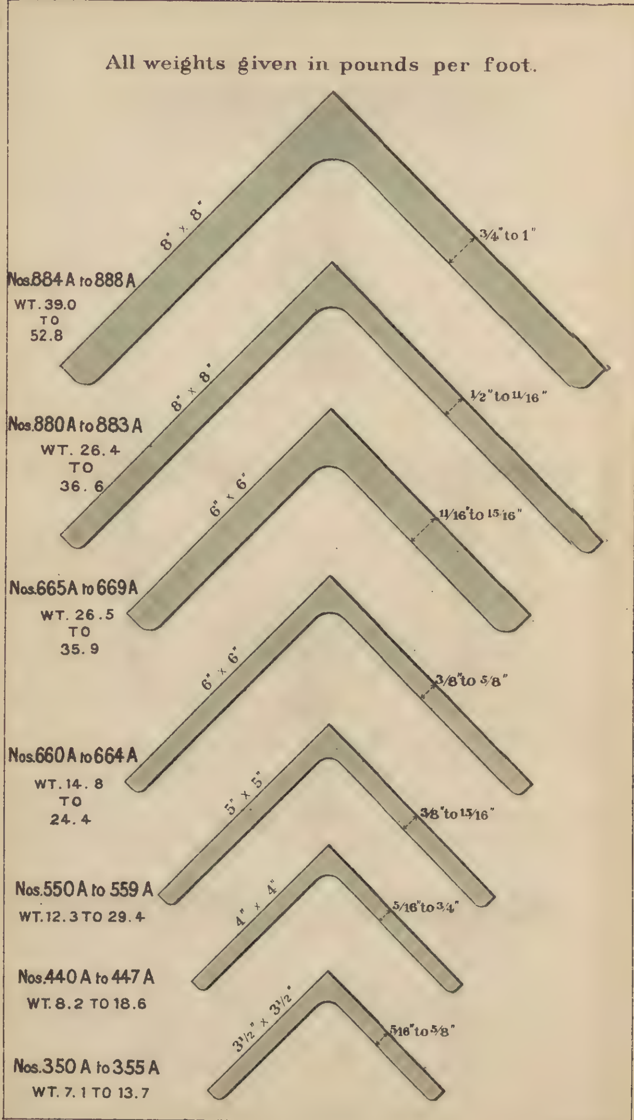


Plate No. 27.


All weights given in pounds per foot.
8" x 8"
3/4" to 1"
Nos. 884 A to 888 A
WT. 39.0 TO 52.8
8" x 8"
1/2" to 11/16"
Nos. 880 A to 883 A
WT. 26.4 TO 36.6
6" x 6"
11/16" to 15/16"
Nos. 665 A to 669 A
WT. 26.5 TO 35.9
6" x 6"
3/8" to 5/8"
Nos. 660 A to 664 A
WT. 14.8 TO 24.4
5" x 5"
3/8" to 15/16"
Nos. 550 A to 559 A
WT. 12.3 TO 29.4
4" x 4"
5/16" to 3/4"
Nos. 440 A to 447 A
WT. 8.2 TO 18.6
3 1/2" x 3 1/2"
5/16" to 5/8"
Nos. 350 A to 355 A
WT. 7.1 TO 13.7

All weights given in pounds per foot.

Nos. 330 A to 336 A
WT. 4.9 TO 11.5

Nos. 275 A to 279 A
WT. 4.5 TO 8.6

Nos. 250 A to 255 A
WT. 3.1 TO 7.8

Nos. 225 A to 228 A
WT. 2.7 TO 5.4

Nos. 220 A to 223 A
WT. 2.5 TO 4.8

Nos. 175 A to 178 A
WT. 2.1 TO 4.1

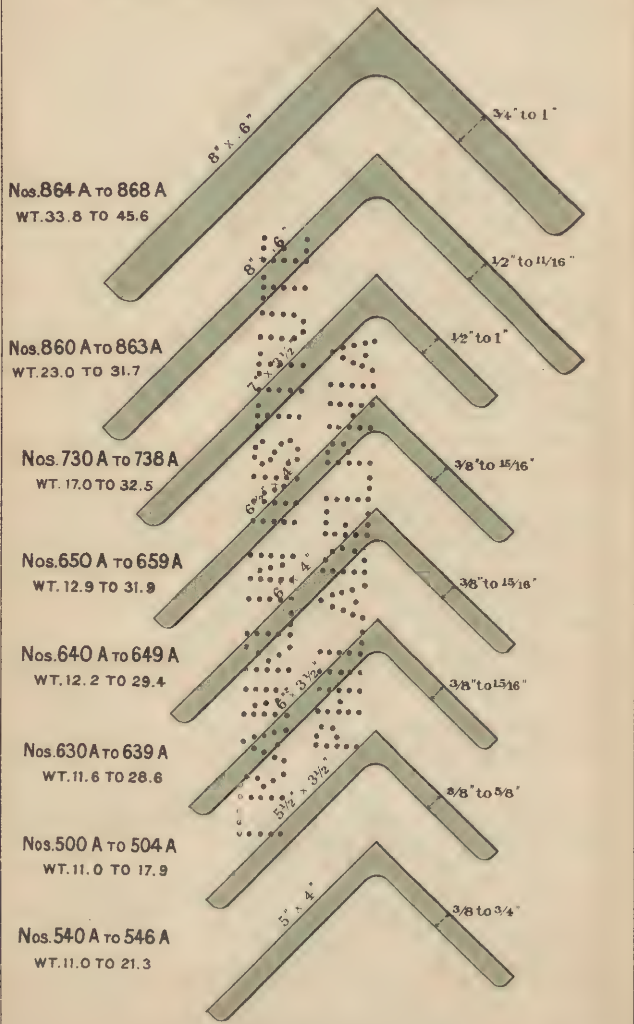
Nos. 150 A to 154 A
WT. 1.2 TO 3.5

Nos. 125 A to 127 A
WT. 1.0 TO 2.0

Nos. 110 A to 112 A
WT. 0.8 TO 1.5

Plate No. 29.

All weights given in pounds per foot



All weights given in pounds per foot.

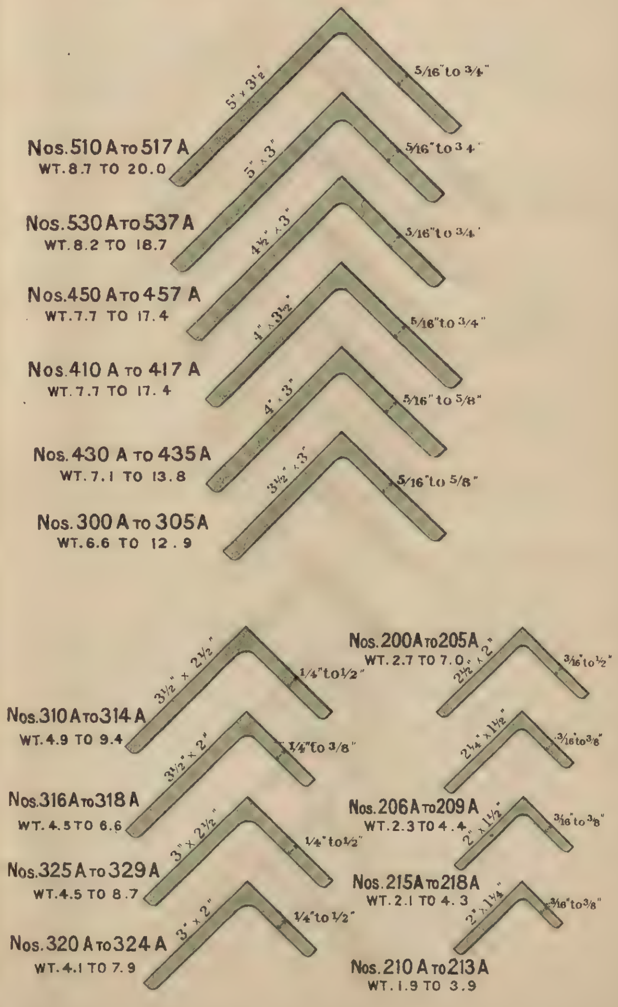
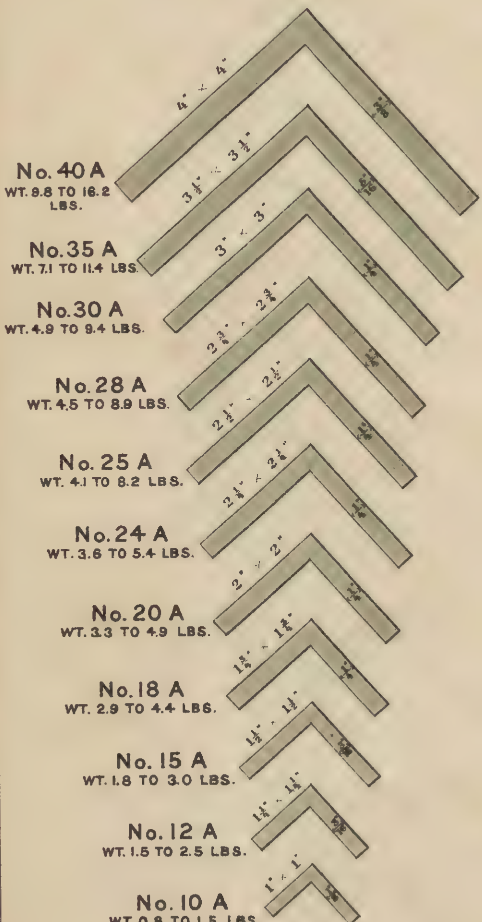


Plate No. 31

All weights given in pounds per foot



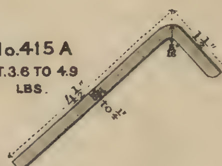
All weights given in pounds per foot.

No. 22 A
WT. 2.4 TO 4.8 LBS.

No. 278 A
WT. 4.2 TO 6.4 LBS.

No. 23 A
WT. 2.6 TO 5.3 LBS.

No. 415 A
WT. 3.6 TO 4.9 LBS.



No. 26 A
WT. 3.0 TO 8.1 LBS.

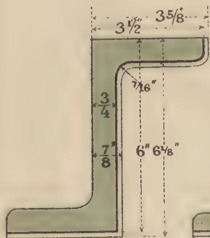
No. 27 A
WT. 4.4 TO 8.8 LBS.

No. 217 M
WT. 50 LBS.
Area 14.7

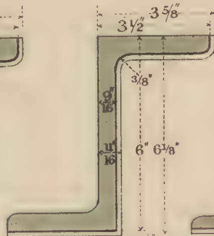
No. 33 A
WT. 4.8 TO 11.5 LBS.

Plate No. 33.

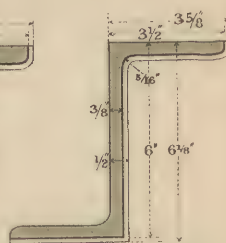
All weights given in pounds per foot.



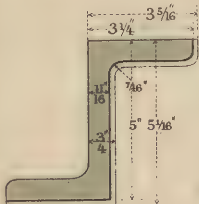
Nos. 66-67-68 Z
WTS. 29.4-31.9-34.5



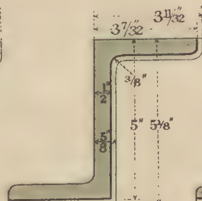
Nos. 63-64-65 Z
WTS. 22.7-25.4-28.0



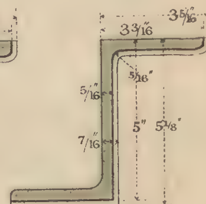
Nos. 60-61-62 Z
WTS. 15.6-18.3-21.0



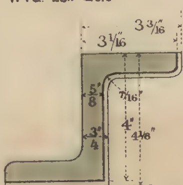
Nos. 56-57 Z
WTS. 23.7-26.0



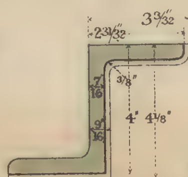
Nos 53-54-55 Z
WTS. 17.8-20.1-22.4



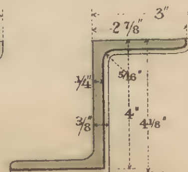
Nos. 50-51-52 Z
WTS 11.4-13.8-16.1



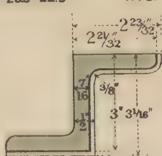
Nos. 46-47-48 Z
WTS. 18.8-20.9-22.9



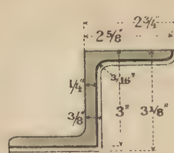
Nos. 43-44-45 Z
WTS. 13.5-15.5-17.5



Nos. 40-41-42 Z
WTS. 7.9-9.9-11.9



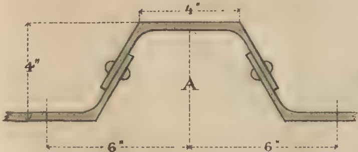
Nos. 33-34-35 Z
WTS. 11.1-11.9-12.7



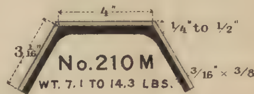
Nos. 30-31-32 Z
WTS. 6.6-8.3-10.0

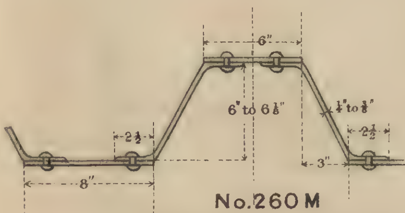
Trough Shaped Sections for Corrugated Flooring

All weights given in pounds per foot.



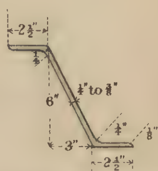
WT. PER SQ FOOT 14.8 TO 29.1 LBS.





No.260 M

WT. PER SQ FOOT 20.0 TO 40.1 LBS.



WT. PER FT. 9.8 TO 14.7 LBS.

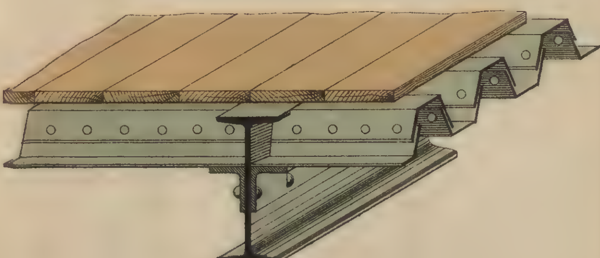
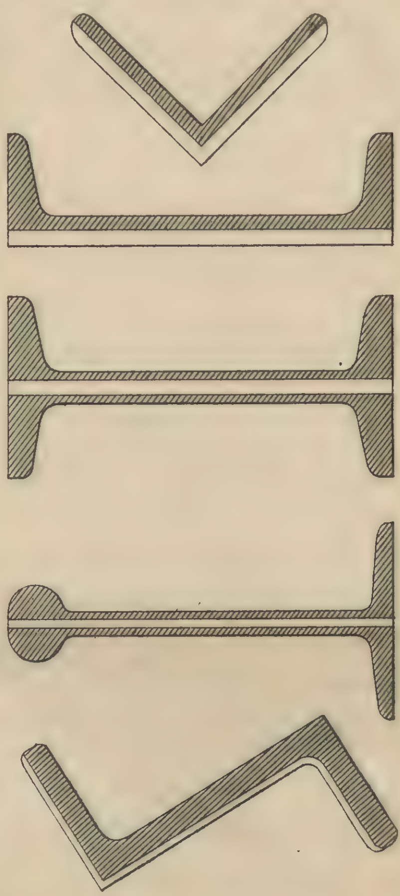


Plate No.35.

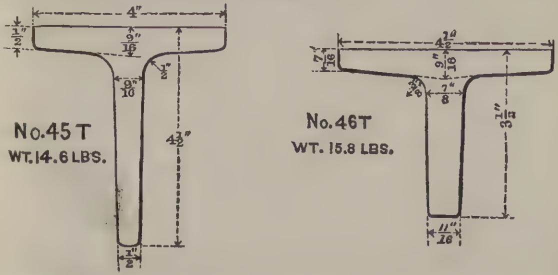
METHOD OF INCREASING SECTIONAL AREAS.

Cross hatched portions represent the minimum sections and the blank portions the added areas..



ELEMENTS OF PENCOYD TEES.

Since going to press one new Tee, section No. 46 T, has been added and No. 45 T has been altered. The sections, weights and properties of these are given below:



			46 T	45 T
I.	*Section Number.*		46 T	45 T
II.	*Size in Inches.*		4½″ x 3½″	4″ x 4½
III.	*Area in Square Inches.*		4.65	4.29
IV.	*Weight in Pounds per Foot.*		15.8	14.6
V.	*Moments of Inertia.*	*Axis A. B.*	4.93	7.87
VI.		*Axis C. D.*	3.67	2.80
VII.	*Resistance.*	*Axis A. B.*	2.05	2.50
VIII.		*Axis C. D.*	1.63	1.40
IX.	*Radius of Gyration.*	*Axis A. B.*	1.03	1.37
X.		*Axis C. D.*	0.89	0.81
XI.	*Distance "d" Base to Neutral Axis.*		1.11	1.37
	Coefficient of Safe Load Axis A. B. in Net Tons.		10.91	13.39

SAFE LOAD IN NET TONS UNIFORMLY DISTRIBUTED.

Fibre stress 16,000 lbs. per square inches.

Section No.	*Size Flange by Stem Inches.*	*Weight per Foot in Lbs.*	*LENGTH OF SPAN IN FEET.* 4	5	6	7	8	9	10	11	12	13
			Safe Load in Net Tons.									
46T	4½ x3 ½	15.8	2.73	2.18	1.82	1.56	1.37	1.21	1.09	0.99	0.91	0.84
45T	4 x4 ½	14.6	3.35	2.68	2.23	1.91	1.67	1.49	1.34	1.22	1.12	1.03

Plate No. 35.